# Volume – II

# TECHNICAL SPECIFICATIONS

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# Introduction & General Information

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# Section-01

# INTRODUCTION and GENERAL INFORMATION

This Volume II of the Tender Document describes the technical specifications for Communication System Package which includes overhead fibre optic cable (OPGW), associated communication equipment & DC power supply for North Eastern Region. These systems are being procured by the Employer (Power Grid Corporation of India Limited) as part of the Establishment of Fibre Optic Communication Systems in lieu of existing ULDC microwave links in North Eastern Region of India.

The intent of this project is to implement a fibre optic cable based communication network which will be implemented in lieu of existing microwave links as well as to provide additional capacity for catering present & future requirements.

This Specification describes the functional and performance requirements of the system. The purpose of this section of the specification is to provide general information about the package, general requirements, responsibilities & obligations of contractor as well as Employer, and general bidding requirements.

## 1.1 Project Overview

POWERGRID has implemented System Coordination & Control (SC&C) projects on regional basis for providing advance EMS/SCADA and Communication System for Management of Regional Power Grids. These projects are also known as Unified Load Despatch Communication (ULDC) projects. These ULDC projects were commissioned progressively from July 2002 to February 2006 in Southern, Northern, North-Eastern, Eastern & Western regions.

The wideband communication network built under North Eastern Region SC&C project consists of Fiber Optic and Digital Microwave (MW) links. The Digital Microwave links are operating in the 2.3 to 2.5 GHz frequency range. As per GOI guidelines, it has been decided by DoT to allocate 2.3 to 2.4 GHz frequency band to Broadband Wireless Access (BWA) services and therefore this frequency band is to be vacated by the POWERGRID. Accordingly, fibre optic based communication system is to be established in lieu of existing MW system under North Eastern Region ULDC. The fibre optic cable shall be installed on POWERGRID Transmission Line as well as the Transmission lines of State Power Transmission Utilities in North Eastern Region.

In view of the urgent requirement, few of the links are being installed by diverting OPGW & associated hardware accessories from an ongoing project in Northern region on replenishment basis. The Contractor under this package shall install the replenished OPGW & associated hardware accessories in Northern Region as mentioned in **Appendix B**.

## 1.2 Existing Communication System

The existing wideband communication system for the North Eastern Region comprises of Digital Microwave links supporting bit rate of 4 x 2 Mbps and Fibre Optic links with supporting bit rate of STM-1. The wideband communication network is providing voice & data connectivity among Control Centres and from RTUs to Control Centre. The Digital Microwave Radio links are working along with PDH equipments. The subscribers are also connected to PDH equipments and voice/data channels are working. The existing wideband communication network is given in Appendix-A.

## 1.3 Proposed Communication System

The proposed communication system shall be fibre optic based and shall consist of overhead and underground fibre optic links with a minimum bit rate of Synchronous Transport Module-4 (STM-4). The scope of the telecommunication system procurement for the Project includes design, supply, installation, testing and implementation of a fully integrated wideband telecommunications network consisting of overhead fibre optic systems.

Communication Network diagram proposed in support of "Establishment of Fibre Optic Communication System in lieu of existing ULDC Microwave links in North Eastern Region" is given in Appendix-A.

The Contractor shall provide fibre optic links in lieu of existing Microwave Radio links. The switchover of the traffic from Microwave Radio equipment to fibre optic equipment shall be planned to avoid downtime.

## 1.4 Scope & General Requirements

The scope of this package is described in following parts:

### Part-I – Fibre Optic Cable

The broad scope of the procurement of this part include the survey, planning, design, engineering, manufacturing, supply, transportation, insurance, delivery at site, unloading, handling, storage, installation, splicing, termination, testing, training, and demonstration for acceptance, commissioning and documentation for:

a) OPGW fibre optic cable including all associated hardware , accessories & fittings
b) Fibre Optic approach cable including installation material
c) Fibre Optic Distribution Panels (FODP) & Joint Box
d) Supply of spares and test equipment
e) All other associated work/items described in the technical specifications.

Most of the OPGW fibre optic cables under this project shall be installed under live line conditions, i.e. with all the circuits of the transmission line charged to their rated voltage. However, some of OPGW cables may be installed in off-line conditions. The tentative bill of quantities for both live-line as well as off-line OPGW cable system installations have been

specified in the appendices and the actual quantities for both types shall be finalised during project execution after detailed survey.

The Contractor has to carry out the detailed survey and collect the required data for preparation of drum schedule. For Fibre Optic links in the Northern Region, the survey has already been completed and the survey reports shall be provided to the contractor for finalisation of drum schedule.

* The erection/installation of OPGW cable on new transmission lines shall be carried out by Transmission Line Package Contractor under the supervision of Communication System Package Contractor. The details of the survey carried out by the Transmission Line Contractors along with tower spotting data shall be provided to Communication System Package Contractor for this line. Full co-ordination will be required between this Package Contractor and Tower Package Contractor. In particular, the required lengths and schedule of delivery of drums of OPGW and installation fittings shall be co-ordinated and agreed between both parties. The Communication System Package contractor shall be responsible for OPGW cable testing before handing over of OPGW cable drums and after installation of OPGW cable in presence of Transmission Line Package Contractor. The splicing, testing and commissioning shall be carried out by the Communication System Package Contractor.

Usage of the OPGW cable along with hardware & accessories for other Projects within India

The Employer reserves the right to divert the OPGW cable along with associated hardware & accessories for requirement in any other Project on replenishment basis. The OPGW drum schedule and associated hardware & accessories BoQ shall be provided by the employer for the quantity required for diversion inline with the main quantity. The payment shall be made on the basis of route length as specified for main quantities. The installation of replenished OPGW & associated hardware accessories shall be done by the Contractor inline with the main quantity.

The various sections of this specifications defines the survey, design, performance, installation, testing & implementation for the fibre optic cable system.

**Part-II : Terminal Equipment System**

The broad scope of the procurement of this part include the survey, planning, design, engineering, manufacturing, supply, transportation, insurance, delivery at site, unloading, handling, storage, installation, termination, testing, training, and demonstration for acceptance, commissioning, maintenance and documentation for:

a) SDH Equipment along with suitable interfaces & line cards etc.
b) Associated Termination equipment system including E-1 channel banks & drop-insert muldems, Sub-channel dataplexing, subscriber line interfacing card and digital access & cross-connect switching (DACS).
c) Network Management System(NMS)
d) -48 Volts DC Power Supply & Battery system

e) All cabling, wiring, Digital Distribution Frame patch facilities, equipment MDF's and interconnections to the supplied equipment at the defined interfaces.
f) All equipment MDF & DDF cross connects required to route and activate circuits.
g) System integration of the supplied subsystems and also integration with existing communication equipment such as SDH, MUX etc.
h) System integration of the supplied PDH equipments(termination equipment system) with existing PDH equipments (MUX, Drop-Insert & DACS) for seamless transmission of communication channel
i) Integration of supplied system with RTUs, PLCC equipment, FODP, Clock, PABX etc.
j) Reconfiguration of communication channel in existing communication equipment
k) Maintenance of the supplied system
l) Supply of spares and test equipment

The above mentioned scope of work specified in Part-II shall be applicable for following two broad categories.

**CATEGORY A:**

These are the new links with new equipments such as SDH, PDH, DDF, MDF & DCPS etc to be implemented under the contract. The work involves in this category is highlighted as below:

- Inter connection of subscribers such as RTUs, PLCC, and PABX with PDH equipments thru MDF.
- Inter connection of SDH with FODP & SDH to PDH equipments through DDF.

**CATEGORY B:**

Fibre Optic links shall be implemented in place of existing Digital Microwave Radio links. Implementation work shall be carried out in manner down time of running channels is minimized. The work involves in this category is highlighted as below:

- Inter connection of SDH equipment with the existing PDH equipments thru new DDF
- NMS channel of existing PDH equipments to be transported on new FO links.
- Power supply connection to new SDH equipments with existing -48 V DCPS.
- Integration of new PDH equipments with existing PDH equipment for RTU to Control Centre connectivity
- All existing E-1 channels presently running on digital microwave links to be shifted on fibre optic link.

There could be the possibility of requirement of only PDH equipment at some locations and necessary cabling & wiring shall be in scope of this package contractor. The contractor shall be responsible for reconfiguration/re-routing of running communication channels, which may necessitate due change in network topology.

In addition to above mentioned works, if any other work, required for fully functional system, shall also be in the scope of contractor.

### 1.4.1 Communication Equipment Integration

The Contractor shall be responsible for integration with various communication network subsystems viz. Fibre Optic transmission subsystem, Termination subsystem, FO Cabling system, and also integration with existing fibre optic communication network & PLCC network to ensure satisfactory overall wideband network performance. The Contractor shall ensure that end-to-end data and voice channel requirements of RTUs and control centres are satisfied. Integration shall consist of activities at wideband nodes as listed but not limited to the following:

(i) All necessary interconnections and interfacing including supply and installation of cables, wires, MDF/DDF to MDF/DDF cross connects, additional cards/equipment required for establishing proper inter connections for data, voice, synchronization etc. Connections may also be required between MDF/DDF located in different building/nearby sites.
(ii) Detailed channel routing at subscriber channel level, E-1 channel plan etc. and equipment configuration.
(iii) System wide synchronization
(iv) Consolidated floor plans indicating the location (to be approved by the Employer) of supplied equipment as well as the equipment which interfaces are required/provided.
(v) Necessary programming/modifications to ensure compatibility between signaling for voice channels interfaces with other equipment such as PABX etc.
(vi) The contractor shall integrate new termination equipment sub-system with the existing termination equipment. Alternatively contractor may also provide any other solution for seamless transmission of communication channels.

### 1.4.2 Details of Existing Equipment

The make /model number of the existing equipment are as under.

1. Multiplexer Equipment : Make - ABB, Model : FOX515
2. Drop-Insert Multiplexer Equipment : Make - ABB, Model : FOX515
3. DACS Equipment : Make - ABB, Model : FOX515 (Separate DACS Equipment not used)
4. SDH Equipment : Make - Siemens, Model - SMA 1/4
5. Network Management System of ABB & Siemens

### 1.4.3 Synchronization of the Communication Network

The existing communication network is synchronized with external GPS clock located at RLDC Shillong . The Contractor shall be responsible for synchronization of new communication equipment with existing network utilizing the existing clock. The Contractor shall make an assessment of additional slave clock requirement for synchronization of the communication equipment.

### 1.4.4 General Technical Requirements (for Communication Equipment)

(i) The SDH equipment / Primary multiplexer shall be offered from a manufacturer(s) who has been manufacturing SDH equipment/Primary multiplexer for the last three (3) years and SDH equipment / Primary multiplexer manufactured by such manufacture(s) shall have been in satisfactory operation in 110 kV or higher voltage Power substations for at least two (2) years as on the date of opening of Bids.

(ii) The installation of communication equipment shall be done by a firm who has previous experience of installation, testing and commissioning of at least 20 nodes of Fibre Optic Transmission System based on SDH technology which and at least 5 no. of these nodes must be in satisfactory operation for at least two (2) years as on date of opening of bids.

### 1.4.5 General Requirements

The Contractor is encouraged to offer standard products and designs. However, the Contractor must conform to the requirements and provide any special equipment necessary to meet the requirements stated herein.

It should be noted that preliminary information and bill of quantity (BoQ) specified in this specification are indicative only. The Contractor shall verify the data during the site surveys & detail engineering and finalise the BoQ as required for ultimate design & system performance. The Bidder's proposal shall address all functional and performance requirements within this specification and shall include sufficient information and supporting documentation in order to determine compliance with this specification without further necessity for inquiries.

The Bidder's proposal shall clearly identify all features described in the specifications or in any supporting reference material that will not be implemented; otherwise, those features shall become binding as part of the final contract.

An analysis of the functional and performance requirements of this specification and/or site survey, design, and engineering may lead the Contractor to conclude that additional items (hardware/software) are required within the intent of this specification that are not specifically mentioned in this specification. The Contractor shall be responsible for providing at no added cost to the Employer, all such additional items such that a viable and fully functional fibre optic cabling system is implemented that meets or exceeds the capacity and performance requirement specified. Such materials shall be considered to be within the scope of the contract. To the extent possible, the Bidders shall identify and include all such additional items (hardware/ software) in their proposal.
The offered items shall be designed to operate in varying environments. Adequate measures shall be taken to provide protection against rodents, contaminants, pollutants, water & moisture, lightning & short circuit, vibration and electro-magnetic interference etc.

The Contractor shall demonstrate a specified level of performance of the offered fibre optic cables & associated hardware & fittings during well structured factory tests and field tests.

All equipment provided shall be designed to interface with other equipment and shall be supporting all present requirements and spare capacity requirement identified in the technical specifications.

The bidders are advised to visit sites/routes (at their own expense), prior to the submission of proposal, and make surveys and assessments as deemed necessary for proposal submission. The successful bidder (Contractor) is required to visit all sites. The site visits/routes shall include all necessary surveys to allow the contractor to perform the design and implementation functions. The Contractor shall inform their site/route survey schedule to the Employer well in advance. The site/route survey schedule shall be finalised in consultation with the Employer. The Employer may be associated with the Contractor during their site/route survey activities.

After the site/route survey the Contractor shall submit to the Employer a survey report on each link and site. This report shall include at least the following items:

a. List of all span lengths and the total link length for OPGW cable routes.
b. Suitability for live line installation of OPGW cable on the present infrastructure, towers, earthwire, etc.
c. Tower wise identification of type(s) and numbers of fittings & accessories required.
d. Proposed splice locations and cable drum schedules.
e. Proposed routing of the approach cable from the end tower/ gantry to the communication room to be marked on the site layout drawing. The existing cable trenches/ cable raceways proposed to be used shall be identified. In case suitable existing cable trenches are not available, suitable alternatives shall be suggested.
f. Proposed layout of Equipment in the existing rooms and buildings.
g. Proposed routing of power, earthing, signal cables and patch cords etc.
h. Confirmation of adequacy of Space and AC/DC Power supply requirements
i. Proposals for new rooms/buildings if required
j. Identification of facility modifications if required
k. Identify all additional items required for integration for each site/location.

## 1.5 Systems to be supported

The following systems shall be supported by the proposed Communications Network.

### 1.5.1 EMS/SCADA Systems

The Fibre Optic communication system shall support the data & voice requirement for SCADA/EMS. Some of the RTUs channels are transported to Control Centre either through PLCC or through PLCC up to wideband node.

## 1.6 General Responsibilities and Obligations

This section describes the general responsibilities and obligations of the Contractor and the Employer.

### 1.6.1 Responsibilities for the Implementation Plan

The Bidder's technical proposal shall include a project implementation plan and schedule that is consistent with the implementation plan detailed in the technical specification. The implementation plan shall be modelled such that it provides Communication equipment system support for SCADA/EMS system for the Project. The Implementation plan shall include the activities of both the Contractor and the Employer, showing all key milestones and clearly identifying the nature of all information and project support expected from the Employer. The Employer and Contractor shall finalise the detailed Implementation plan following award of the contract.

### 1.6.2 Contractor Responsibilities and Obligations

The Contractor shall be responsible for implementation of Communication System Package.

The Contractor shall be responsible for all cables and wiring associated with the equipment provided, both inside and outside buildings in accordance with technical specifications. The Contractor shall also be responsible for determining the adequacy of the local power source for the equipment and for wiring to it, with adequate circuit protective breakers. In addition, the Contractor shall be responsible for shielding equipment and cabling to eliminate potential interference to or from the equipment, and for earthing all cabinets and shields.

The Contractor's obligations include, but are not limited to, the following:

(1) Provide a working system that meets the functional and performance requirements of this specification.

(2) Obtaining statutory clearances from regulatory bodies, statutory bodies such as municipality, highway authority, electrical utilities, forest department, gas authorities etc. on behalf of Employer as detailed in technical specifications.

(3) Engineering and design specific to each location including review of, and conformance with local environmental and earthing requirements.

(4) Inputs for finalisation of installation and safety guidelines and procedures for the stringing, mechanical installation as required.

(5) Development of installation guidelines and procedures for the stringing, mechanical installation, and splicing of all Overhead Fibre Optic Cable, including testing and documentation.

(6) Project management, project scheduling, including monthly project reports documenting progress during the contract period.

(7) Co-ordination with Tower Package Contractors for phased implementation and commissioning of the overall OPGW cable

(8) Engineering and technical assistance during the contract and warranty period and annual maintenance contract (AMC) Period.

(9) Site visits, path surveys, and studies necessary to identify and provide all equipment needed to implement the FO cables installation.

(10) Overall integration of communication equipments/subsystem procured in present and other telecom packages of the SC&C project & existing network

(11) All cabling, wiring including supply, laying and termination etc of the cables, and main distribution frame (MDF) at wideband nodes required for full interconnectivity and proper operation of the telecommunications network including equipment supplied under this package and the connectivity and interfacing of PLC, PABX etc.

(12) Connectivity between the FODP and SDH equipment.

(13) Providing –48 Volts DCPS system & Battery.

(14) Installation and integration of network management software, hardware and firmware.

(15) Provide all additional Equipment necessary to ensure compatibility between new and existing equipment.

(16) Implement all minor civil works and identify any major civil works i.e. expansion or construction of rooms, trenches necessary for installation of proposed equipment and provide the details of such work to the Employer.

(17) Define source power requirements for each cabinet/ rack of equipment provided at each location.

(18) All hardware, software, and firmware required to satisfy the requirements of this Specification.
(19) Factory and site testing of all hardware, software, and firmware provided.
(20) Provide documented evidence of satisfactory Type Test performance to the Employer and if required by The Employer, conduct type test.
(21) Provide a Quality Assurance Plan, ensuring the Employer access to the manufacturing process.
(22) Shipment of all equipment and documentation to the Employer designated locations and/or staging areas.
(23) Staging, maintenance of staging area and security including full responsibility for protection from theft and fire.

(24) An availability analysis showing MTBF (mean-time-between-failure) and MTTR (mean-time-to-repair) figures for all system components.

(25) Hardware, software, and firmware maintenance, debugging, and support of the equipment

through final acceptance, and maintenance on all new equipment through the warranty period and for a period of six(6) years after warranty period.

(26) Availability of service, spare and expansion parts for the supplied items for the designed life of the item or seven (7) years after the declaration of withdrawal of equipment from production, whichever is earlier. However, the termination of production shall not occur prior to Operational Acceptance of the system by the Employer.

(27) Notification services for field updates to the hardware, software, and firmware for ensuring the availability of the supplied hardware & software including NMS for the entire lifespan.

(28) Integration with existing PDH equipments (MUX, Drop-Insert, DACS) with new provided equipments (MUX, Drop-Insert, DACS, SDH).

(29) For any renovation, expansion or construction of facilities required to be carried out by Employer, the Contractor shall provide in the survey report the details necessary to enable such work to be carried out.

(30) Assessment of suitability for live line installation of overhead FO cable on the present infrastructure, towers etc.

(31) Design and Installation of the mechanical assemblies and accessories, including vibration dampers required for installation of all overhead fibre cable. To conduct structural analysis and to carry out tower strengthening if required, any or all additional steel work or modifications required to attach the overhead fibre cables shall also be carried out by the Contractor. Design data of towers shall be provided by the Employer.

(32) Dismantling the existing earthwire & hardware wherever overhead FO cables (OPGW) is to be installed on existing lines, and for the preservation and transportation of the dismantled earthwire & hardware to designated stores.

(33) Factory and Site acceptance testing of all equipment provided.

(34) Conduct type tests and provide documented evidence of satisfactory Type Test performance to the Employer.

(35) Provide a Quality Assurance Plan ensuring the Employer access to the manufacturing process.

(36) Shipment of all equipment and documentation to the Employer designated locations and/or staging areas.

(37) Staging, maintenance and security of staging area including full responsibility for protection from theft and fire.

(38) All documentation and drawings as specified.

(39) Training of the Employer personnel.

(40) All required spare parts, maintenance aids, and test equipment.

(41) All Fibre Optic Distribution frame patch facilities.

(42) Maintenance and support of the equipment through final acceptance, and maintenance on all new equipment through the warranty period and annual maintenance contract period.

(43) Ensure the availability of service, spare and expansion parts for all equipment for the life of the equipment.

(44) Due diligence in properly planning and executing the work so as to minimise any damage to crop, forestry or vegetation, internal utilities of any private or government party.

(45) The contractor shall appoint key personnel for the project such as Project Manager, Site Manager, Design Engineer, Installation Engineer and Commissioning Engineer only after approval of the experience data by the Employer. Approval of the Employer shall be obtained, whenever the Contractor wants to change key personnel.

Detailed descriptions of the Contractor's obligations, in relation to individual items of hardware, functions and services, are delineated in other sections of this specification.

### 1.6.3 The Employer Responsibilities and Obligations

The Employer will provide the following items and services as part of the procurement Project:

(1) Overall project management of the Project.

(2) Review and approval of the Contractor's designs, drawings, survey report and recommendations.

(3) Communication network configuration data, including:
- (a) Channel assignments for voice and data
- (b) Interconnection drawings for existing equipment, including MDFs.

(4) Review and approval of test procedures.

(5) Participation in and approval of Type, Factory and Site Acceptance tests.

(6) Review & approval of training plans

(7) Providing support and access to facilities at the sites.

(8) Implement major civil works such as expansion or construction of room, necessary renovations required for the equipment to be provided by the Contractor.

(9) Provide to the extent possible drawings for existing sites and facilities for which equipment installation are planned.

(10) Assistance in Obtaining statutory clearances from regulatory bodies, payment of restoration charges

(11) Compensation for crop, forestry or vegetation damage unavoidably caused by the Contractor during the course of performance of work. The Contractor shall take due diligence in properly planning and executing the work so as to minimise any such damage.

(12) Approval of the key personnel for the project.

## 1.7 General Bidding Requirements

The Bidder shall be responsive to the Employer's technical requirements as set forth in this specification. The Bidder's proposal shall include the following:

(1)The Technical Proposal including the documents listed in the table 1-1: Bid Documents Checklist, shall be provided in the bid.

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(3) The bidder shall submit with their proposal, performance certificates for all the offered equipment i.e. SDH, Multiplexer, DCPS etc. from at least one customer. The performance certificates shall provide evidence of successful operation of the proposed equipment for at least one year as on date of bid opening.

(4) A commitment and a clearly defined plan to provide system support in India and capability of providing a full range of local services for the life of the delivered systems.

(5) The bidder may offer the bought-out items from more than one manufacturer. In case of QR items, the bidder shall provide supporting qualification document also.

**Table 1-1;**
**Bid Documents Checklist**

| S.No. | Description: | Enclosure Reference | |
|---|---|---|---|
| | | | |
| 1 | Completed Data Requirement Sheets<br>(As per relevant Sections of Technical Specs) | Page no.<br>Ref no. | |
| 2 | Quality Assurance Program<br>(As per relevant Sections of Technical Specs ) | Page no.<br>Ref no. | |
| 3 | Technical brochures/details of the offered product | Page no.<br>Ref no. | |

**Table 1-1;**
**Bid Documents Checklist**

| S.No. | Description: | Enclosure Reference | |
|---|---|---|---|
| 4 | Performance Certificate | Page no.<br>Ref no. | |

## 1.8 Table of Compliance

Bidder shall use one copy of Volume I, "Conditions of Contract," and Volume II, "Technical Specifications" to indicate compliance status with those volumes. Within the right-hand margin, Bidder shall indicate compliance status to each paragraph along with a cross-reference to its proposal and an index key for any explanation or comment.

In addition, the Bidder shall annotate the Table of Contents of each of the above stated volumes to provide a high-level summary of compliance status. In both cases, the following symbols, and no others, shall be used:

C - Bid complies with all requirements in the adjacent paragraph.

A - Bid is not compliant with the requirements in the adjacent paragraph, but a functional alternative is proposed.

X - Bid takes exception to the requirements of the adjacent paragraph and no functional alternative is proposed.
Only one symbol shall be assigned a paragraph and shall indicate the worst case level of compliance for that paragraph. This annotation may be handwritten.

Bidder shall also underline, on the compliance copy, all requirements to which exceptions have been taken (X) or to which alternatives have been proposed (A).

Each alternative shall be clearly and explicitly described. Such descriptions shall use the same paragraph numbering as the bid document sections addressed by the alternatives. All alternative descriptions shall be in one contiguous section of the Bidder's proposal, preferably in the same volume, and titled "Alternatives." A separate section titled "Exceptions" should be provided containing any discussion or explanation Bidder chooses to provide concerning exceptions taken. Alternatives which do not substantially comply with the intent of the bid documents will be considered exceptions.

The Employer will assess the merits of each alternative and exception and will be the sole judge as to their acceptance.

## 1.9 Organization of The Technical Specification Document

Sections & appendices of technical specifications provides the technical & implementation

requirements of the Package.

Section 2 : OPGW cabling and associated hardware & fittings
Section 3: Network Configuration and Equipment Characteristics
Section 4: DC Power Supply System
Section 5: Environment, EMI, Power Supply, Cabling and Earthing
Section 6: Inspection and testing requirements
Section 7: Training and Support Services
Section 8: Documentation & deliverable requirements
Section 9: Project management, schedule and implementation requirements.

Appendix A - General requirements & Implementation Schedule
Appendix B - Bill of Quantity
Appendix C - Data Requirement Sheets

## 1.10 Applicable Standards

The applicable standards are mentioned in the respective technical section. The offered equipment shall conform to the standards mentioned in the specification except to the extent modified by this specification. In case of any discrepancy between the description given in the specification and the standards, the provisions of the technical specification shall be followed. The parameters not specifically mentioned in this specification shall conform to the standard mentioned in this specification.

Specifications and codes shall be the latest version, inclusive of revisions, which are in force at the date of the contract award. Where new specifications, codes, and revisions are issued during the period of the contract, the Contractor shall attempt to comply with such, provided that no additional expenses are charged to the Employer without Employer's written consent.
In the event the Contractor offers to supply material and/or equipment in compliance to any standard other than Standards listed herein, the Contractor shall include with their proposal, full salient characteristics of the new standard for comparison.

## 1.11 References

(1) CIGRE Guide for Planning of Power Utility Digital Communications Networks

(2) CIGRE Optical Fibre Planning Guide for Power Utilities

(3) CIGRE New Opportunities for Optical Fibre Technology in Electricity Utilities

(4) CIGRE guide to fittings for Optical Cables on Transmission Lines.

**……..End of the Section……**

## Section-2

## OPGW Cabling & Associated Hardware & Fittings

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# Section-2

## OPGW cabling and associated hardware & fittings

This section describes the functional & technical specifications of OPGW cabling and associated hardware & fittings.

### 2.1 Fibre Optic Cabling

This section defines the requirements for G.652D Dual-window Single mode (DWSM) telecommunications grade fibre optic cable. Bidders shall furnish with their bids, detailed descriptions of the fibres & cable(s) proposed.

All optical fibre cabling including fibre itself and all associated installation hardware shall have a minimum guaranteed design life span of 25 years. Documentary evidence in support of guaranteed life span of cable & fibre shall be submitted by the Contractor during detailed engineering.

#### 2.1.1 Required Optical Fibre Characteristics

This section describes the characteristics of optical fibre to be provided under this specification.

##### 2.1.1.1 Physical Characteristics

Dual-Window Single mode (DWSM), G.652D optical fibres shall be provided in the fibre optic cables. DWSM optical fibres shall meet the requirements defined in Table 2-1(a).

##### 2.1.1.2 Attenuation

The attenuation coefficient for wavelengths between 1525 nm and 1575 nm shall not exceed the attenuation coefficient at 1550 nm by more than 0.05 dB/km. The attenuation coefficient between 1285 nm and 1330 nm shall not exceed the attenuation coefficient at 1310 nm by more than 0.05 dB/km. The attenuation of the fibre shall be distributed uniformly throughout its length such that there are no point discontinuities in excess of 0.10 dB. The fibre attenuation characteristics specified in table 2-1 (a) shall be "guaranteed" fibre attenuation of any & every fibre reel.

The overall optical fibre path attenuation shall not be more than calculated below:

Maximum attenuation @ 1550nm: 0.21 dB/km x total km + 0.05 dB/splice x no. of splices + 0.5 dB/connector x no. of connectors

Maximum attenuation @ 1310nm: 0.35dB/km x total km + 0.05 dB/splice x no. of splices + 0.5 dB/connector x no. of connectors

**Table 2-1(a)**
**DWSM Optical Fibre Characteristics**

| | |
|---|---|
| **Fibre Description:** | Dual-Window Single-Mode |
| **Mode Field Diameter:** | 8.6 to 9.5 μm (± 0.6μm ) |
| **Cladding Diameter:** | 125.0 μm ± 1 μm |
| **Mode field concentricity error** | ≤ 0.6μm |
| **Cladding non-circularity** | ≤ 1% |
| **Cable Cut-off Wavelength $\lambda_{cc}$** | ≤ 1260 nm |
| **1550 nm loss performance** | As per G.652 D |
| **Proof Test Level** | ≥ 0.69 Gpa |
| **Attenuation Coefficient:** | @ 1310 nm ≤ 0.35 dB/km<br>@ 1550 nm ≤ 0.21 dB/km |
| **Chromatic Dispersion; Maximum:**<br><br><br><br>**Zero Dispersion Wavelength:**<br>**Zero Dispersion Slope:** | 18 ps/(nm x km) @ 1550 nm<br>3.5 ps/(nm x km) 1288-1339nm<br>5.3 ps/(nm x km) 1271-1360nm<br><br>1300 to 1324nm<br>0.092 ps/(nm$^2$xkm) maximum |
| **Polarization mode dispersion coefficient** | ≤ 0.2 ps/km^½ |
| **Temperature Dependence:** | Induced attenuation ≤ 0.05 dB (-60°C - +85°C ) |
| **Bend Performance:** | @ 1310 nm (75±2 mm dia Mandrel), 100 turns;<br>Attenuation Rise ≤ 0.05 dB<br>@ 1550 nm (30±1 mm radius Mandrel), 100 turns;<br>Attenuation Rise ≤ 0.05 dB<br>@ 1550 nm (32±0.5 mm dia Mandrel, 1 turn;<br>Attenuation Rise ≤ 0.50 dB |

### 2.1.2 Fibre Optic Cable Construction

Overhead Fibre Optic Cables shall be OPGW (Optical Ground Wire). The OPGW cable is proposed to be installed on transmission lines. The design of cable shall account for the varying operating and environmental conditions that the cable shall experience while in service. The OPGW cable to be supplied shall be designed to meet the overall requirements of all the transmission lines. Normally the tower span of the lines shall not exceed 600m, however, some of the spans may be up to around 1000m or more. The exact details shall be collected by the Contractor during survey. To meet the overall requirement of all the transmission lines, the contractor may offer more than one design without any additional cost to POWERGRID, in case span length of more than 600m is found during survey. It may also be noted that some of the transmission lines route may be added during the engineering stage.

### 2.1.2.1 Transmission Line Details

Typical details of transmission lines are indicated in the Appendices. Any other details, as required for cable design etc. shall be collected by the Contractor during survey.

### 2.1.2.2 Optical Fibre Cable Link Lengths

The estimated optical fibre link lengths are provided in Appendices. However, the Contractor shall supply & install the optical fibre cable as required based on detailed site survey to be carried out by the Contractor during the project execution. The Contract price shall be adjusted accordingly.

For the purpose of payment, the optical fibre link lengths are defined as transmission line route lengths from Gantry at one terminating station to the Gantry in the other terminating station. The actual cable lengths to be delivered shall take into account various factors such as sag, service loops, splicing, working lengths & wastage etc. and no additional payment shall be payable in this regard. The unit rate for FO cable quoted in the Bid price Schedules shall take into account all such factors.

### 2.1.2.3 Optical Fibre Identification

Individual optical fibres within a fibre unit and fibre units shall be identifiable in accordance with EIA/TIA 598 or IEC 60304 or Bellcore GR-20 colour-coding scheme.

Colouring utilized for colour coding optical fibres shall be integrated into the fibre coating and shall be homogenous. The colour shall not bleed from one fibre to another and shall not fade during fibre preparation for termination or splicing.

Each cable shall have traceability of each fibre back to the original fibre manufacturer's fibre number and parameters of the fibre. If more than the specified number of fibres are included in any cable, the spare fibres shall be tested by the cable manufacturer and any defective fibres shall be suitably bundled, tagged and identified at the factory by the vendor.

### 2.1.2.4 Buffer Tube

Loose tube construction shall be implemented. The individually coated optical fibre(s) shall be surrounded by a buffer for protection from physical damage during fabrication, installation and operation of the cable. The fibre coating and buffer shall be strippable for splicing and termination. Each fibre unit shall be individually identifiable utilizing colour coding. Buffer tubes shall be filled with a water-blocking gel.

### 2.1.2.5 Optical Fibre Strain & Sag-tension chart

The fibre optic cable shall be designed and installed such that the optical fibres experience no strain under all loading conditions defined in IS 802. Zero fibre strain condition shall apply even after a 25 year cable creep.

For the purpose of this specification, the following definitions shall apply:

- *Maximum Working Tension (MWT)* is defined as the maximum cable tension at which there is *no fibre strain.*

- The *no fibre strain* condition is defined as fibre strain of less than or equal to 0.05%, as determined by direct measurements through IEC/ ETSI (FOTP) specified optical reflectometry techniques.
- The *Cable strain margin* is defined as the maximum cable strain at which there is no fibre strain.
- The cable *Maximum Allowable Tension (MAT)* is defined as the maximum tension experienced by the Cable under the worst case loading condition.
- The cable *max strain* is defined as the maximum strain experienced by the Cable under the worst case loading condition.
- The cable *Every Day Tension (EDT)* is defined as the maximum cable tension on any span under normal conditions.
- The *Ultimate /Rated Tensile Strength (UTS/* RTS/ breaking strength) is defined as the maximum tensile load applied and held constant for one minute at which the specimen shall not break.

While preparing the Sag-tension charts for the OPGW cable the following conditions shall be met:

- The Max Allowable Tension (MAT) / max strain shall be less than or equal to the MWT/ Strain margin of the cable.
- The sag shall not exceed the earth wire sag in all conditions.
- The Max Allowable Tension shall also be less than or equal to 0.4 times the UTS.
- The 25 year creep at 25% of UTS (creep test as per IEEE 1138) shall be such that the 25 year creep plus the cable strain at Max Allowable Tension (MAT) is less than or equal to the cable strain margin.
- The everyday tension (EDT) shall not exceed 20% of the UTS for the OPGW cable.

The Sag-tension chart of OPGW cable indicating the maximum tension, cable strain and sag shall be calculated and submitted along with the bid under various conditions mentioned below:

1. 53° C , no wind and no ice
2. 32° C, no wind and no ice
3. 0°C, no wind and no ice
4. 32° C, full wind and no ice
5. 32° C, 75% full wind and no ice
6. 0° C, 2/3$^{rd}$ / 36% of full wind (IS 802:1977/1995)

The above cases shall be considered for the spans from 100 m to 600 m or higher span length in the range of 50 m spans. Max. vertical sag, max. tension and max sag at 0° C & no wind shall be considered for in line with the design parameter of transmission line. The typical details are indicated in the Appendices. The full wind load shall be considered as the design wind load for all the specified transmission lines as per relevant IS 802 version and the sag-tension chart shall be submitted considering the transmission lines. The Contractor shall submit the stringing chart for review of Employer.

### 2.1.2.6 Cable Materials

The materials used for optical fibre cable construction, shall meet the following requirements:

#### 2.1.2.6.1 Filling Materials

The interstices of the fibre optic unit and cable shall be filled with a suitable compound to prohibit any moisture ingress or any water longitudinal migration within the fibre optic unit or along the fibre optic cable. The water tightness of the cable shall meet or exceed the test performance criteria as per IEC-794-1-F-5.

The filling compound used shall be a non-toxic homogenous waterproofing compound that is free of dirt and foreign matter, nonhygroscopic, electrically nonconductive and non-nutritive to fungus. The compound shall also be fully compatible with all cable components it may come in contact with and shall inhibit the generation of hydrogen within the cable.

The waterproofing filling materials shall not affect fibre coating, colour coding, or encapsulant commonly used in splice enclosures, shall be dermatologically safe, non-staining and easily removable with a non-toxic cleaning solvent.

#### 2.1.2.6.2 Metallic Members

When the fibre optic cable design incorporates metallic elements in its construction, all metallic elements shall be electrically continuous.

#### 2.1.2.6.3 Marking, Packaging and Shipping

This section describes the requirements for marking, packaging and shipping the overhead fibre optic cable.

(a) Drum Markings: Each side of every reel of cable shall be permanently marked in white lettering with the vendors' address, the Purchaser's destination address, cable part number and specification as to the type of cable, length, number of fibres, a unique drum number including the name of the transmission line & segment no., factory inspection stamp and date.

(b) Cable Drums: All optical fibre cabling shall be supplied on strong drums provided with lagging of adequate strength, constructed to protect the cabling against all damage and displacement during transit, storage and subsequent handling during installation. Both ends of the cable shall be sealed as to prevent the escape of filling compounds and dust & moisture ingress during shipment and handling. Spare cable caps shall be provided with each drum as required.

The spare cable shall be supplied on sturdy, corrosion resistant, steel drums suitable for long periods of storage and re-transport & handling.

There shall be no factory splices allowed within a continuous length of cable. Only one continuous cable length shall be provided on each drum. The lengths of cable to be supplied on each drum shall be determined by a "schedule" prepared by the Contractor.

### 2.1.2.7 OPGW cable installation requirements

Most of the OPGW fibre optic cables to be installed under this project shall be installed under live line conditions, i.e. with all the circuits of the transmission line charged to their rated voltage. However, some of OPGW cables may be installed in off-line conditions. The tentative bill of quantities for both live-line as well as off-line OPGW cable system installations have been specified in the appendices and the actual quantities for both types shall be finalised during project execution after detailed survey.

Under live line installation, the OPGW cable shall be installed on transmission lines under live line conditions, i.e. with all the circuits of the transmission line charged to their rated voltage.

The OPGW cable shall be installed at the top of the tower by replacing the existing ground wire. The Contractor shall carry out re-tensioning of the existing earth wire wherever required to maintain the adequate clearances for live line stringing of fibre optic cables. However, in exceptional cases installation of OPGW cable below conductor may also be considered on low voltage lines which shall be decided during detailed engineering.

For the new Transmission lines namely **Namsai(PG) to Tinsukia**, the stringing of OPGW cable shall be carried out by Transmission Line Tower Package Contractor(s) as per the stringing chart/procedure submitted by them and approved by Employer/Communication system Package Contractor. The splicing work shall be carried out by Communication system Package Contractor. All hardware & fittings needed to tie the OPGW to the towers/gantries shall be provided by Communication system Package Contractor to the transmission line tower contractor**.**

While handing over the OPGW drums, the testing (fibre loss and length measurement using OTDR) of OPGW in each drum shall be carried out by Communication system Package Contractor in presence of Tower package contractor(s) and Employer's representative. After installation of OPGW cable, the testing of each section shall be carried out again by the Communication System Package Contractor in presence of Tower package contractor(s) and Employer representative. In case of any damage/high loss in the fibre, the total length of that particular section of OPGW cable shall be replaced by Tower package Contractor(s). Communication System Package Contractor shall supply new OPGW cable drum in place of damaged cable drum. The Contract price shall be adjusted accordingly.

**Supervision of Installation** -The Communication System Package Contractor shall supervise the stringing at site as per the approved stringing procedure. Site visit for supervision shall be carried out as per instructions of Employer. The man-days for site supervision is identified in Appendix-B. However, the contract price shall be adjusted as per the actual requirement. The Supervision/Inspection work in Contractor's scope shall mainly include inspection as per stringing procedure, proper location of drum site, installation of stringing blocks/pulleys, proper sagging, proper installation of hardware, proper tension as per Sag-Tension chart, provision of service loops of OPGW in jointing locations etc.

### 2.1.2.8 Optical Ground Wire (OPGW)

OPGW cable construction shall comply with IEEE-1138, 2009. The cable provided shall meet both the construction and performance requirements such that the ground wire function, the optical fibre integrity and optical transmission characteristics are suitable for the intended purpose. The cable shall consist of optical fibre units as defined in this specification. There shall be no factory splices within the cable structure of a continuous cable length.

The composite fibre optic overhead ground wire shall be made up of multiple buffer tubes embedded in a water tight aluminium / aluminium alloy/stainless steel protective central fibre optic unit surrounded by concentric-lay stranded metallic wires in single or multiple layers. Each buffer tube shall have maximum 12 no. of fibres. All fibres in a single buffer tube or directly in central fibre optic unit is not acceptable. The dual purpose of the composite cable is to provide the electrical and physical characteristics of conventional overhead ground wire while providing the optical transmission properties of optical fibre.

#### 2.1.2.8.1 Central Fibre Optic Unit

The central fibre optic unit shall be designed to house and protect multiple buffered optical fibre units from damage due to forces such as crushing, bending, twisting, tensile stress and moisture. The central fibre optic unit and the outer stranded metallic conductors shall serve together as an integral unit to protect the optical fibres from degradation due to vibration and galloping, wind and ice loadings, wide temperature variations, lightning and fault current, as well as environmental effects which may produce hydrogen.

The OPGW design of dissimilar materials such as stainless steel tube with aluminium or aluminium – clad-steel wire strands are not allowed. Central fibre optic unit may be of aluminium or stainless steel tube with aluminium protective coating. In case of aluminium protective coating, the coating must completely cover the tubes leaving no exposed areas of tubing that can make electrical contact either directly or indirectly through moisture, contamination, protrusions, etc with the surrounding stranded wires. The tube may be fabricated as a seamless tube, seam welded, or a tube without a welded seam.

#### 2.1.2.8.2 Basic Construction

The cable construction shall conform to the applicable requirements of this specification, applicable clauses of IEC 61089 related to stranded conductors and Table 2.2(a) OPGW Mechanical and Electrical Characteristics. In addition, the basic construction shall include bare concentric-lay-stranded metallic wires with the outer layer having left hand lay. The wires may be of multiple layers with a combination of various metallic wires within each layer. The direction of lay for each successive layer shall be reversed. The finished wires shall contain no joints or splices unless otherwise agreed to by the Employer and shall conform to all applicable clauses of IEC 61089 as they pertain to stranded conductors.

The wires shall be so stranded that when the complete OPGW is cut, the individual wires can be readily regrouped and then held in place by one hand.

#### 2.1.2.8.3 Breaking Strength

The rated breaking strength of the completed OPGW shall be taken as no more than 90 percent of the sum of the rated breaking strengths of the individual wires, calculated from their nominal diameter and the specified minimum tensile strength.

The rated breaking strength shall not include the strength of the optical unit. The fibre optic unit shall not be considered a load bearing tension member when determining the total rated breaking strength of the composite conductor.

### 2.1.2.8.4 Electrical and Mechanical Requirements

Table 2-2(a) provides OPGW Electrical and Mechanical Requirements for the minimum performance characteristics. Additionally, the OPGW mechanical & electrical characteristics shall be similar to that of the earthwire being replaced such that there is no or minimal consequential increase in stresses on towers. For the purposes of determining the appropriate Max Working Tension limit for the OPGW cable IS 802:1995 and IS 875: 1987 shall be applied. However the OPGW installation sag & tension charts shall be based on IS 802 version to which the line is originally designed. For the OPGW cable design selection and preparation of sag tension charts, the limits specified in this section shall also be satisfied. The Bidder shall submit sag-tension charts for the above cases with their bids.

**Table 2.2(a)**
**OPGW Electrical and Mechanical Requirements**

| | | |
|---|---|---|
| **(1)** | **Everyday Tension** | ≤ 20% of UTS of OPGW |
| **(2)** | **D.C. Resistance at 20°C:** | < 1.0 ohm/Km |
| **(3)** | **Short Circuit Current:** | ≥ 6.32 kA for 1.0 second |

### 2.1.2.8.5 Operating conditions

Since OPGW shall be located at the top of the EHV transmission line support structure, it will be subjected to Aeolian vibration, Galloping and Lightning strikes. It will also carry ground fault currents. Therefore, its electrical and mechanical properties shall be same or similar as those required of conventional ground conductors.

### 2.1.2.8.6 Installation

OPGW installed under live line condition, i.e. with all circuits charged to the rated line voltage as specified in this section shall be generally in accordance with the IEEE Guide to the Installation of Overhead Transmission Line Conductors (IEEE STD. 524 with latest revisions), with additional instructions and precautions for live line working and fibre optic cable handling. The stringing procedure shall be submitted by the Contractor prior to stringing for Employer's approval.

A tower structural analysis shall be carried out by the Contractor, based on the relevant data to be provided by Employer, to ensure that with the replacement of existing earthwire with the OPGW cable, the tower members remain within the statutory safety limits as per Indian Electricity rules and if required the Contractor shall carry out the tower strengthening as necessary. The OPGW cable sections shall normally be terminated & spliced only on tension towers. In exceptional circumstances, and on Employer specific approval, cable may be terminated on Suspension towers, but in this case tower strength shall be examined to ensure that tower loads are within safe limits and if required, necessary tower strengthening shall be carried out by the Contractor.

### 2.1.2.8.7 Installation Hardware

The scope of supply of the optical cable includes the assessment, supply and installation of all required fittings and hardware such as Tension assembly, Suspension assembly, Vibration dampers, Reinforcing rods, Earthing clamps, Downlead clamps, splice enclosure etc. The Bidder shall provide documentation justifying the adequacy and suitability of the hardware supplied. The quantity of hardware & fittings to meet any eventuality during site installation min. @1% shall also be provided as part of set/km. for each transmission line without any additional cost to POWERGRID. The Contractor shall determine the exact requirements of all accessories required to install and secure the OPGW.

The OPGW hardware fittings and accessories shall follow the general requirements regarding design, materials, dimensions & tolerances, protection against corrosion and markings as specified in clause 4.0 of EN 61284: 1997 (IEC 61284). The shear strength of all bolts shall be at least 1.5 times the maximum installation torque. The OPGW hardware & accessories drawing & Data Requirement Sheets (DRS) document shall consist of three parts: (1) A technical particulars sheet (2) An assembly drawing i.e. level 1 drawing and (3) Component level drawings i.e. level 2 & lower drawings. All component reference numbers, dimensions and tolerances, bolt tightening torques & shear strength and ratings such as UTS, slip strength etc shall be marked on the drawings.

The fittings and accessories described herein are indicative of installation hardware typically used for OPGW installations and shall not necessarily be limited to the following:

(a) Suspension Assemblies: Preformed armour grip suspension clamps and aluminium alloy armour rods/ reinforcing rods shall be used. The suspension clamps shall be designed to carry a vertical load of not less than 25 KN. The suspension clamps slippage shall occur between 12kN and 17 kN as measured in accordance with type test procedures specified in Appendix, Vol. II.

The Contractor shall supply all the components of the suspension assembly including shackles, bolts, nuts, washers, split pins, etc. The total drop of the suspension assembly shall not exceed 150 mm (measured from the centre point of attachment to the centre point of the OPGW). The design of the assembly shall be such that the direction of run of the OPGW shall be the same as that of the conductor.

(b) Dead End Clamp Assemblies: All dead end clamp assemblies shall preferably be of performed armoured grip type and shall include all necessary hardware for attaching the assembly to the tower strain plates. Dead end clamps shall allow the OPGW to pass through continuously without cable cutting. The slip strength shall be rated not less than 95% of the rated tensile strength of the OPGW.

(c) Clamp Assembly Earthing Wire: Earthing wire consisting of a 1500 mm length of aluminium or aluminium alloy conductor equivalent in size to the OPGW shall be used to earth suspension and dead end clamp assemblies to the tower structure. The earthing wire shall be permanently fitted with lugs at each end. The lugs shall be attached to the clamp assembly at one end and the tower structure at the other.

(d) Structure Attachment Clamp Assemblies: Clamp assemblies used to attach the OPGW to the structures, shall have two parallel grooves for the OPGW, one on either side of the connecting bolt. The clamps shall be such that clamping characteristics do not alter adversely when only one OPGW is installed. The tower attachment plates shall locate the OPGW on the inside of

the tower and shall be attached directly to the tower legs/cross-members without drilling or any other structural modifications.

(e) Vibration Dampers: Vibration dampers type 4R Stockbridge or equivalent, having four (4) different frequencies spread within the Aeolian frequency bandwidth corresponding to wind speed of 1m/s to 7 m/s, shall be used for suspension and tension points in each span. The Contractor shall determine the exact numbers and placement(s) of vibration dampers through a detailed vibration analysis as specified in technical specifications.

One damper minimum on each side per OPGW cable for suspension points and two dampers minimum on each side per OPGW cable for tension points shall be used for nominal design span of 400 meters. For all other ruling spans, the number of vibration damper shall be based on vibration analysis.

The clamp of the vibration damper shall be made of high strength aluminum alloy of type LM-6. It shall be capable of supporting the damper and prevent damage or chaffing of the conductor during erection or continued operation. The clamp shall have smooth and permanent grip to keep the damper in position on the OPGW cable without damaging the strands or causing premature fatigue failure of the OPGW cable under the clamp. The clamp groove shall be in uniform contact with the OPGW cable over the entire clamping surface except for the rounded edges. The groove of the clamp body and clamp cap shall be smooth, free from projections, grit or other materials which could cause damage to the OPGW cable when the clamp is installed. Clamping bolts shall be provided with self locking nuts and designed to prevent corrosion of threads or loosening in service.

The messenger cable shall be made of high strength galvanised steel/stain less steel. It shall be of preformed and post formed quality in order to prevent subsequent droop of weight and to maintain consistent flexural stiffness of the cable in service. The messenger cable other than stainless steel shall be hot dip galvanised in accordance with the recommendations of IS:4826 for heavily coated wires.

The damper mass shall be made of hot dip galvanised mild steel/cast iron or a permanent mould cast zinc alloy. All castings shall be free from defects such as cracks, shrinkage, inclusions and blow holes etc. The surface of the damper masses shall be smooth.

The damper clamp shall be casted over the messenger cable and offer sufficient and permanent grip on it. The messenger cable shall not slip out of the grip at a load less than the mass pull-off value of the damper. The damper masses made of material other-than zinc alloy shall be fixed to the messenger cable in a suitable manner in order to avoid excessive stress concentration on the messenger cables which shall cause premature fatigue failure of the same. The messenger cable ends shall be suitably and effectively sealed to prevent corrosion. The damper mass made of zinc alloy shall be casted over the messenger cable and have sufficient and permanent grip on the messenger cable under all service conditions.

The contractor must indicate the clamp bolt tightening torque to ensure that the slip strength of the clamp is maintained between 2.5 kN and 5 kN. The clamp when installed on the OPGW cable shall not cause excessive stress concentration on the OPGW cable leading to permanent deformation of the OPGW strands and premature fatigue failure in operation.

The vibration analysis of the system, with and without damper and dynamic characteristics of the damper as detailed in Technical Specification, shall have to be submitted. The technical particulars for vibration analysis and damping design of the system are as follows:

| Sl. No. | Description | Technical Parameters |
|---|---|---|
| 1. | Span Length in meters<br>(i) Ruling design span:<br>(ii) Maximum span:<br>(iii) Minimum Span: | <br>400 meters<br>1100 meters<br>100 meters |
| 2. | Configuration: | As per Specifications |
| 3. | Tensile load in each: | As per sag tension calculations |
| 4. | Armour rods used: | Standard preformed armour rods/AGS |
| 5. | Maximum permissible dynamic strain: | +/- 150 micro strains |

The damper placement chart for spans ranging from 100m to 1100m shall be submitted by the Bidder. Placement charts should be duly supported with relevant technical documents and sample calculations.

The damper placement charts shall include the following:
(1) Location of the dampers for various combinations of spans and line tensions clearly indicating the number of dampers to be installed per OPGW cable per span.
(2) Placement distances clearly identifying the extremities between which the distances are to be measured.
(3) Placement recommendation depending upon type of suspension clamps (viz Free center type/Armour grip type etc.)
(4) The influence of mid span compression joints, repair sleeves and armour rods (standard and AGS) in the placement of dampers

### 2.1.3 Fibre Optic Splice Enclosures (Joint Box)

All splices shall be encased in Fibre Optic Splice Enclosures. Suitable splice enclosures shall be provided to encase the optical cable splices in protective, moisture and dust free environment. Splice enclosures shall comply to ingress protection class IP 66 or better. The splice enclosures shall be designed for the storage and protection of required number of optical fibre splices and equipped with sufficient number of splice trays for splicing all fibres in the cable. No more than 6 fibres shall be terminated in a single splice tray. They shall be filled with suitable encapsulate that is easily removable should re-entry be required into the enclosures.
Splice enclosures shall be suitable for outdoor use with each of the cable types provided under this contract. Splice enclosures shall be appropriate for mounting on transmission line towers above anti-climb guard levels at about 10 metres from top of the tower and shall accommodate pass-through splicing. The actual mounting height and location shall be finalised after Survey. Contractor shall be responsible for splicing of fibres and installation of splice enclosures.

### 2.1.3.1 Optical Fibre Splices

Splicing of the optical fibre cabling shall be minimized through careful Contractor planning. There shall be no mid-span splices allowed. All required splices shall be planned to occur on tower structures. All optical fibre splicing shall comply with the following:

(a) All fibre splices shall be accomplished through fusion splicing.

(b) Each fibre splice shall be fitted with a splice protection sheath fitted over the final splice.

(c) All splices and bare fibre shall be neatly installed in covered splice trays. No more than six (6) fibres shall be installed in each splice tray.

(d) For each link, bi-directional attenuation of single mode fusion splices, shall not average more than 0.05 dB and no single splice loss shall exceed 0.1 dB when measured at 1550 nm.

(e) For splicing, fibre optic cable service loops of adequate length shall be provided so that all splices occurring at tower structures can be performed at ground level.

### 2.1.4 Fibre Optic Approach Cables

For purposes of this specification, a fibre optic approach cable is defined as the Armoured underground fibre optic cable required to connect Overhead Fibre Optic Cable (OPGW) between the final in line splice enclosure on the gantry / tower forming the termination of the fibre cable on the power line and the Fibre Optic Distribution Panel (FODP) installed within the building. The estimated fibre optic approach cabling length requirements are indicated in the appendices. However, the Contractor shall supply & install the optical fibre approach cable as required based on detailed site survey to be carried out by the Contractor during the project execution and the Contract price shall be adjusted accordingly.

### 2.1.4.1 Basic Construction

The cable shall be suitable for direct burial, laying in trenches & PVC/Hume ducts, laying under false flooring and on indoor or outdoor cable raceways.

### 2.1.4.2 Jacket Construction & Material

The Approach Cable shall be a UV resistant, rodent proof, armoured cable with metallic type of armouring. The outer cable jacket for approach cable shall consist of carbon black polyethylene resin to prevent damage from exposure to ultra-violet light, weathering and high levels of pollution. The jacket shall conform to ASTM D1248 for density.

### 2.1.4.3 Optical, Electrical and Mechanical Requirements

Approach cable shall contain fibres with identical optical/ physical characteristics as those in the OPGW cables. The cable core shall comprise of tensile strength member(s), fibre support/bedding structure, core wrap/bedding, and an overall impervious jacket.

### 2.1.5 Installation of Approach Cable

The existing cable trenches/ cable raceways proposed to be used shall be identified in the survey report. The Contractor shall make its best effort to route the cable through the existing available cable trenches. Where suitable existing cable trenches are not available, suitable alternatives shall be provided after Employer approval. However, the approach cable shall be laid in the HDPE pipe in all condition.

Suitable provisions shall be made by the Contractor to ensure adequate safety earthing and insulated protection for the approach cable.

All required fittings, supports, accessories, ducts, inner ducts, conduits, risers and any item not specially mentioned but required for laying and installation of approach cables shall be supplied and installed by the Contractor.

### 2.1.6 Optical Fibre Termination and Splicing

Optical fibre terminations shall be installed in Fibre Optic Distribution Panels (FODP) designed to provide protection for fibre splicing of preconnectorized pigtails and to accommodate connectorized termination and coupling of the fibre cables. The Contractor shall provide rack /wall mounted Fibre Optic Distribution Panels (FODPs) sized as indicated in the appendices and shall terminate the fibre optic cabling up to the FODPs. The location of FODP rack shall be fixed by the Contractor, with the Employer's approval.

#### 2.1.6.1 Fibre Optic Distribution Panel

At each location requiring the termination of at least one fibre within a cable, all fibres within that cable shall be connectorized and terminated in Fibre Optic Distribution Panels in a manner consistent with the following:

(a) All fibre optic terminations shall be housed using FODPs provisioned with splice organizers and splice trays. All fibres within a cable shall be fusion spliced to preconnectorized pigtails and fitted to the "Back-side" of the provided fibre optic couplings.

(b) FODPs shall be suitable for use with each of the cable types provided as part of this contract. FODPs shall accommodate pass-through splicing and fibre terminations.

(c) FODPs for indoor use shall be supplied in suitable cabinets/racks with locking arrangement

(d) All FODPs shall be of corrosion resistant, robust construction and shall allow both top or bottom entry for access to the splice trays. Ground lugs shall be provided on all FODPs and the Contractor shall ensure that all FODPs are properly grounded. The FODP shall meet or exceed ingress protection class IP55 specifications.

(e) Flexible protection shall be provided to the patch cord bunches going out from FODP to other equipment.

### 2.1.6.2 Optical Fibre Connectors

Optical fibres shall be connectorised with FC-PC type connectors preferably. Alternatively connector with matching patch cord shall also be acceptable. Fibre optic couplings supplied with FODPs shall be appropriate for the fibre connectors to be supported. There shall be no adapters.

### 2.1.7 Service Loops

For purposes of this specification, cable and fibre service loops are defined as slack (extra) cable and fibre provided for facilitating the installation, maintenance and repair of the optical fibre cable plant.

(a) Outdoor Cable Service Loops: In-line splice enclosures installed outdoors and mounted on the utility towers, shall be installed with sufficient fibre optic cable service loops such that the recommended minimum bend radius is maintained while allowing for installation or maintenance of the cable to be performed in a controlled environment at ground level.

(b) Indoor Cable Service Loops: FODPs shall provide at least three (3) metres of cable service loop. Service loops shall be neatly secured and stored, coiled such that the minimum recommended bend radius' are maintained.

(c) Fibre Units Service Loops: For all fibre optic cable splicing, the cable shall be stripped back a sufficient length such that the fan-out of fibre units shall provide for at least one (1) metre of fibre unit service loop between the stripped cable and the bare fibre fan-out.

(d) Pigtail Service Loops : Connectorised pigtails spliced to bare fibres shall provide at least 1 metre of service loop installed in the FODP fibre organizer and at least one (1) metre of service loop to the couplings neatly stored behind the FODP coupling panels.

(e) Fibre Service Loops : At least 0.5 metre of bare fibre service loop shall be provided on each side of all fibre splices. The bare fibre service loops shall be neatly and safely installed inside covered splice trays.

### 2.1.8 Methodology for Installation and Termination

All optical fibre cable termination, installation, stringing and handling plans, guides and procedures, and engineering analysis (e.g. tension, sag, vibration etc.) shall be submitted to the Employer for review and approval in the engineering/design phase of the project, prior to establishing the final cable lengths for manufacture. Installation procedures including details of personnel and time required shall be documented in detail and submitted to Employer for approval. All installation practices shall be field proven and ISO accredited.

All cable segments shall include service loops as specified in this specifciation. The maximum allowable stringing tension, maximum allowable torsional shear stress, crush strength and other physical parameters of the cable shall not be exceeded. The preventative measures to be taken shall be documented in detail and submitted to Employer in advance of installation.

Optical fibre attenuation shall be measured after installation and before splicing. Any increase in attenuation or step discontinuity in attenuation shall not be acceptable and shall constitute a cable

segment failure. In the event of cable damage or any fibre damage, the complete section (tension location to tension location) shall be replaced as mid-span joints are not acceptable.

Any or all additional steel work or modifications required to attach the fibre cabling to the overhead transmission/ distribution line towers shall also be carried out by the Contractor. It shall be the Contractors responsibility to provide adequate communications among all crew members and support staff to ensure safe and successful installations.

### 2.1.9 Cable Raceways

To the extent possible, existing cable raceways shall be utilised. The Contractor is required to provide and install any additional indoor cable raceways which may be required for proper implementation of the fibre optic cabling system. This requirement shall be finalised during survey. The cable raceways shall conform to the following:

(a) All cable raceways shall be sized to support full loading requirements plus at least a 200% safety loading factor.
(b) Indoor cable raceways shall be fabricated from construction grade aluminium, galvanized iron or anodized sheet metal or any other suitable material approved by the Employer. Suitable anti-corrosion measures shall be provided. Steel fabricated raceways shall be finished inside and out, treated to resist rust and to form a metal-to- paint bond.
(c) Mechanical construction drawings of the cable raceways shall be submitted for Employer's information & review.

**----------End of this Section----------**

# Section 3

## Network Configuration and Equipment Characteristics

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# Section 3

# Network Configuration and Equipment Characteristics

## 3.1 Introduction

This section describes the Fibre Optic Communication network configuration and the equipment characteristics for communication system to be installed under the project. The sub-systems addressed within this section are:

(1) Fibre Optic Transmission System (FOTS)
(2) Termination Equipment Subsystems
(3) Network Management System(NMS)
(4) MDF, DDF and Cabling

The requirements described herein are applicable to and in support of network configurations depicted in Appendix and Network Management System (NMS) for monitoring and control of this communication network. TMN and NMS have been interchangeably used in this specification.

The security related requirements of the equipment shall be as per DoT (Department of Telecommunication) guidelines and all similar security requirements as amended by DoT on time to time basis shall be followed/complied by the vendor at no additional cost to Employer till the implementation of the project.

The manufacturer shall allow the Employer and/or its designated agencies to inspect the hardware, software, design, development, manufacturing,facility and supply chain and subject all software to a security /threat check any time during the supplies of equipment

The contractor shall ensure that the supplied equipments have been got tested as per relevant contemporary Indian or International Security Standards e.g. IT and IT related elements against ISO/IEC 15408 standards, for Information Security Management System against ISO 27000 series Standards, Telecom and Telecom related elements against 3GPP security standards, 3GPP2 security standards etc. from any international agency/ labs of the standards e.g. Common Criteria Labs in case of ISO/IEC 15408 standards until 31$^{st}$ March 2013. From 1$^{st}$ April, 2013, the certification shall be got done from authorized and certified agency/lab in India.

The Contractor shall also ensure that the equipment supplied has all the contemporary security related features and features related to communication security as prescribed under relevant security standards. A list of features, equipments, software etc. supplied and implemented in the project shall be given for use by the Employer

The contractor shall get the Employer's network audited from security point of view once a year from a network audit and certification agency as identified by DoT. The audit of the network shall be carried once in a financial year till the maintenance service contract

in the bid. Network forensics, Network hardening, Network penetration test, Risk assessment, Actions to fix problems and to prevent such problems from reoccurring etc. shall be covered under network audit.

The Contractor shall ensure that all the documents, including software details are supplied to the Employer in English language. A record of all the software updation and changes shall be given to the Employer and any major updation and changes shall be done with the prior approval of the Employer..

During maintenance period the Contractor shall keep a record of all operation and maintenance procedure in the form of manual and shall also maintain a record of all command logs (actual command given, who gave the command, time & date and from where) for a period of 12 months. For next 24 months the same information shall be stored/retained in a non-online mode. A list of all User ID linked with name and other details of the user duly certified by the Employer shall also be maintained.

A record of all supply chains of the products (hardware/software) shall be given to the Employer.

In case of any deliberate attempt for a security breach at the time of procurement or at a later stage after deployment/installation of the equipment or during maintenance, liability and criminal proceedings can be initiated against the Contractor as per guidelines of DoT and any other Government department.

## 3.2 General Network Characteristics

### 3.2.1 Description

The proposed fibre optic communication network consists shall support the voice & data communication requirements of RTUs, SCADA/EMS system and other Power System operational requirements. The communication system shall provide data & voice connectivity across the various locations or connectivity of RTUs with Control Centres. The RTUs located at various locations will report to Control Center using IEC 60870-5-101 or IEC 60870-5-104 Protocol. The proposed communication system shall provide connectivity of some RTUs over TCP/IP protocol using Ethernet interface and other RTUs over serial interface. The offered communication System shall support the communication requirements of RTUs and the SCADA/DMS system described in point to multi point and/or multipoint to multipoint configurations using Ethernet over SDH.

The fibre optic network shall be based on Synchronous Digital Hierarchy (SDH) having bit rate of STM-4. However, the offered equipment can be upgraded to STM-16 by changing the optical card/interface only. The Contractor can propose a system based on higher bit rate systems, if required, so as to meet the link budget requirements or any other specification requirement. The detailed BOQ is described in appendices.

### 3.2.2 Functional Requirement

The primary function of the communication network is to provide a highly reliable voice and data communication system in support of the SCADA/EMS. The communications support requirement for SCADA/EMS system is for low & high speed data, express voice circuits and administrative voice circuits as defined in appendices. A brief summary of the communication system requirements is as follows:

(a) High speed E1 channel support

(b) 64kbps & nx64kbps data channel support

(c) Low speed (300 -1200 bps) data channel support

(d) Voice (2 wires, 4 wires) channel support.

(e) Data transport supporting Network Management channels

(f) The connectivity envisaged between RTUs and Control Centre is Wide Area Network (WAN) on TCP-IP using IEC 60870-5-104 protocol and IEC 60870-5-101 protocol.

### 3.2.3 General Systems Requirements

Required characteristics are defined and specified herein at the system level, subsystem level, and equipment level.

#### 3.2.3.1 System Synchronization

At present the existing network, which is enclosed at Appendix A , is synchronized with one master clock located at RLDC Shillong .

The Contractor shall synchronize the existing equipments and all the new equipments under the contract using existing Master clock and slave clocks, as required. Contractor shall provide the slave clocks as required under the set of clock indicated in BoQ. The contractor shall submit the synchronization plan as per standard ITU-TG.811. All sync equipments proposed under this contract should meet ITU-T G.811 criterion. The holdover quality of slave clock shall meet ITU-T G.812 standard requirements.

The Contractor shall provide system wide synchronization fully distributed throughout the telecom network and connected to all equipments new & existing. The system wide synchronization shall be slaved to existing master clock as per details given above. The Contractor shall submit the synchronization plan for the entire network meeting the requirement of ITU-T G.803. The synchronization plan shall clearly indicate the requirement of additional clock with full justification.

The system equipment requiring "clock" shall be connected to the master clock using external clocking. For this purpose, appropriate interfaces(s) in the transmission &

termination equipment being supplied and all other associated hardware shall be provided by the Contractor.

### 3.2.3.2 System Maintainability

To facilitate performance trending, efficient diagnosis and corrective resolution, the system shall permit in-service diagnostic testing to be executed both locally and from remote locations, manually and/or initiated under TMN control. Such testing shall not affect the functional operation of the system.

Preventive and problem oriented maintenance of the communications system shall be performed using diagnostics tools such as TMN and test equipment. They shall support complete maintenance of all system elements and shall permit the diagnosis of any fault without requiring additional test equipment. The Contractor shall provide specialized training required to operate above mentioned diagnostic tools. For all redundant systems, disconnection and repair of any failed device shall not interrupt the operation of the system.

### 3.2.3.3 System Upgradability and Expandability

Equipment supplied shall be sized (though not necessarily equipped) to support system/ subsystem expansion to full capacity as provided by specified aggregate transmission rates. Equipment units provisioned for equipped subunits shall be terminated at appropriate patching facilities or termination blocks. Power supplies and TMN shall be sized for maximum equipped system capacity.

### 3.2.3.4 Equipment Availability

The availability requirements is categorised in two parts. The Contractor shall ensure the availability for subscriber to subscriber where they are providing the new equipments (MUX/Drop-Insert) under this contract. The availability requirements are as follows, which shall be demonstrated at site for the equipments being provided under this contract:

**A. New nodes with requirement of both SDH & Mux equipment**

(1) The availability of each fibre optic link (E1 to E1) shall be at least 99.999%.
(2) The availability of network end to end (E1 to E1) shall be at least 99.998%.
(3) The average per link subscriber to subscriber availability shall be at least 99.97%. The per link subscriber to subscriber availability is defined as the availability between any two data or voice subscribers between RTU to reporting Control Centre and between control centres.
(4) The network-wide subscriber to subscriber availability shall be atleast 99.8% .The network-wide subscriber to subscriber availability is defined as the availability between any two data or voice subscribers on the wideband network.

**B. New nodes with requirement of SDH equipment only**

(1) The availability of each fibre optic link (E1 to E1) shall be at least 99.999%.
(2) The availability of network end to end (E1 to E1) shall be at least 99.998%.

The calculated availability is defined as the theoretical availability determined by a statistical calculation based on the mean-time-between-failure (MTBF) and the mean-time-to-repair (MTTR) of the components and subsystems comprising the FOTS. The

down time of the fibre optic cable shall not be considered in the aforesaid availability calculations.

In order to ensure that the equipment & configuration proposed by the bidders shall be capable of demonstrating the specified availability figures it is required that the Bidders shall include in their proposal a calculated availability analysis for the proposed equipment/ sub system. The calculated failure rates of the units and the calculated availabilities of the equipment being offered shall be provided in the proposal. The analysis shall be based on an availability block diagram and shall include the mean-time-between failure (MTBF) and mean-time-to-repair (MTTR) of all of the components on the link. The Contractor shall indicate in the analysis the MTBF and MTTR and the resulting availability of each point-to-point link. For this analysis, an MTTR of at least 4 hours shall be assumed.

### 3.2.4 General Equipment Characteristics

All Contractor supplied equipment shall be new and of the finest production quality. The Employer will not accept modules or printed-circuit boards that are modified by appending wires or components. Wired strapping options shall be incorporated in the board design to meet the above requirement.

All applicable requirements stated in this section shall equally apply to the TMN equipment as specified in this Section.

#### 3.2.4.1 Revision Levels and Modifications

All hardware, firmware and software delivered as part of the communications network shall be field proven and at the most of current revision level. All modifications and changes necessary to meet this requirement shall be completed prior to the start of the factory tests or under special circumstances, on written approval by Employer, prior to the completion of SAT.

All field modifications of the hardware, firmware and software that is required to meet installation and/or performance specifications, shall be fully documented as part of the deliverables, both as a separate field modifications record and as corrected equipment/configuration documentation.

### 3.2.4.2 Equipment Capacities

Equipment supplied shall be sized and equipped with sufficient capacity to support BoQ and configuration requirements as identified in the appendices. Each subsystem supplied shall be sized (to be equipped as specified) to support full subsystem expansion.

Data communications channelization required to support the TMN subsystems specified in Technical Specifications (TS) are not identified in the appendices. Therefore, the Contractor is required to size and equip the system to include all channelization and channel cards required to support the TMN function.

### 3.2.4.3 Redundancy Requirements and Protection Schemes

Equipment redundancy and Automatic Protection Schemes (APS) are specified in the Table 3-1. The failure of one element shall not prevent the use of any other that has not failed.

**Table 3-1**
**Equipment Redundancy Requirements Summary**

| | |
|---|---|
| **Fiber Optic transmission Equipment :** | |
| **SDH equipment** | |
| **Power Supply & Converters** ---------- | 1:1 APS or distributed power supply |
| **Common Control* Cards** ---------- | 1:1 APS |
| **DACS (Cross Connect)** | |
| **Power Supply** ---------- | 1:1 APS or distributed power supply |
| **Common control* cards**---------- | 1:1 APS |
| **MUX, DROP/INSERT** | |
| **Power Supply** ---------- | 1:1 APS or distributed power supply |
| *** = Common control cards which are essentially required for operation of the equipment.** | |

The offered equipment shall support at least SNCP **as per standard ITU-T G.841**. In case the equipment offered by the Bidder does not support the above mentioned minimum protection methods, the bidder shall have to provide all additional equipment needed to provide same level of flexibility, redundancy and functionality at no additional cost to Employer. The bidders shall provide details of protection schemes supported in the Bid document.

The offered equipment shall support automatic switchover function between the redundant modules and all required modules and hardware to support the automatic switch over shall be provided by the Contractor.

#### 3.2.4.4 Lost Signal Recovery

At any digital signal level, reapplication of a lost signal shall result in automatic resynchronization and full restoration to normal operation without manual intervention. All alarms incident to the signal failure, shall be automatically cleared at the equipment, rack and monitoring levels and normal operation indications restored and reported if applicable.

#### 3.2.4.5 Software Upgrades

The Contractor shall provide antivirus software along with all the computer hardware/software which shall be upgraded periodically till the maintenance services contract in the bid. Further, to meet all the specifications requirements during implementation and maintenance, if upgrade in the hardware/software of supplied item is required, the same shall be done by the contractor without any additional cost to the Employer.

### 3.2.5 General Site Considerations

All fiber optic links up to 250 kms transmission line route length shall be implemented by the Contractor without repeaters. In order to meet the link budget requirement, the Contractor shall provide all the necessary equipments only in the end stations. The contractor may provide the optical amplifier, wave length translator, optical cards or high capacity SDH equipment with suitable rack/subrack to meet the maximum distance limit. All the provided equipments shall be monitored by centralized NMS.

### 3.2.6 Proposed Optical Fibre Characteristics

The characteristics of the fibre(s) being installed are provided in the table 3-1(a):

**Table 3-1(a)**
**DWSM Optical Fibre Characteristics**

| | |
|---|---|
| **Fibre Description:** | Dual-Window Single-Mode |
| **Mode Field Diameter:** | 8.6 to 9.5 μm (± 0.6μm ) |
| **Cladding Diameter:** | 125.0 μm ± 1 μm |
| **Core- Clad concentricity error** | ≤ 1.0μm |
| **Mode field concentricity error** | ≤ 0.6μm |
| **Cladding non-circularity** | ≤ 1% |
| **Cable Cut-off Wavelength $\lambda_{cc}$** | ≤ 1260 nm |
| **1550 nm loss performance** | As per G.652 D |
| **Proof Test Level** | ≥ 0.69 Gpą |
| **Attenuation Coefficient:** | @1310nm ≤ 0.35 dB/Km<br>@1550nm ≤ 0.21 dB/Km |
| **Chromatic Dispersion; Maximum:**<br><br><br><br>**Zero Dispersion Wavelength:**<br>**Zero Dispersion Slope:** | 18 ps/(nm x km) @ 1550 nm<br>3.5 ps/(nm x km) 1288-1339nm<br>5.3 ps/(nm x km) 1271-1360nm<br><br>1300 to 1324nm<br>0.092 ps/(nm$^2$xkm) maximum |
| **Polarization mode dispersion coefficient** | ≤ 0.2 ps/km^$^{1/2}$ |
| **Temperature Dependence:** | Induced attenuation ≤ 0.05 dB (-60 deg C - +85 deg C) |
| **Bend Performance:** | @ 1310 nm (75±2 mm dia Mandrel), 100 turns; Attenuation Rise ≤ 0.05 dB<br>@ 1550 nm (30±1 mm radius, Mandrel), 100 turns; attenuation Rise ≤ 0.05 dB<br>@1550 nm(32±0.5 mm dia Mandrel, 1 turn; Attenuation Rise ≤ 0.50 dB |

### 3.2.7 Fibre Optic Link Lengths

The fiber optic route lengths are as specified in appendices. The lengths specified in appendices are the transmission line route lengths; however the actual fiber cable length shall exceed the route lengths on account of extra cable requirement due to sag, jointing

& splicing, approach cabling etc. For bidding purposes the Contractor may assume an additional cable length of 5% of given route length + 1Km towards approach cable for calculating the link length. The exact cable lengths shall be determined by the Contractor during the survey. The same shall be used by the Contractor for final link design during the detailed engineering of the project. In case of change in the specified BoQ, the contract price shall be adjusted accordingly.

## 3.3 Fibre Optic Transmission System

The Fibre Optic Transmission System (FOTS) is defined herein to include ETSI digital optical line termination equipment. The FOTS shall be based on SDH technology. Minimum aggregate bit rate shall be STM-4 and equipped with 2 nos. of minimum 16 port E1 interface(G.703) card & one no. of minimum 4 port Ethernet interface (IEEE 802.3/IEEE 802.3u) card supporting layer 2 switching as tributaries. The Ethernet interfaces shall support VLAN (IEEE 802.1P/Q), spanning tree (IEEE 802.1D) quality of service. . Protection scheme for Ethernet traffic should be ERPS based (Ethernet ring protection scheme) as per ITU-T G.8032.

The Contractor shall provide (supply and install) connectorised jumpers (patch cords) for FODP-to-equipment and equipment-to-equipment connection. Two number spare jumpers shall be provided for each equipment connection. Fiber jumpers shall be of sufficient lengths as to provide at least 0.5m of service loop when connected for their intended purpose.

### 3.3.1 SDH Equipment

#### 3.3.1.1 Functional Requirement

There is a requirement for different types of equipment under this project which are described in this section. The BOQ is provided in the appendices. For the purpose of BOQ, the SDH Equipment is considered to be divided in three parts i.e. Optical Interface/SFP, Tributary Cards ( Electrical tributaries such as E1 & Ethernet 10/100 Mbps) and Base Equipment (Consisting of Common Cards, Control cards, Optical base cards, Power supply cards, sub-rack, cabinet, other hardware and accessories required for installation of equipment i.e. everything besides optical interface/SFP and tributary cards).

If bidder is offering equipment with multifunction cards such as cross-connect or control card with optical interface/SFP or tributary interface, such type of multifunction card shall be considered as Common control card and shall be the part of base equipment. In case optical interface/SFP is embedded with control card, the adequate number of optical interface/SFPs shall be offered to meet the redundancy requirements of the specifications. Further, control card shall not be equipped with more than one optical interface/SFP and optical base card shall not be equipped with more than two optical interface/SFPs.

The equipment shall be configurable either as Terminal Multiplexer (TM) as well as ADM with software settings only.

**SDH ADM**

The aggregate interfaces shall be (at least) STM-4 (622 Mbit/s) towards at least two directions (Protected as specified in this specifications). At present the equipment shall be equipped with a 2 nos., min.16 E-1 port electrical tributary cards & one no., min.4 port Ethernet interface card as tributaries. The Equipment shall provide access to full STM4 payload.

### 3.3.1.2 Redundancy and Protection

Two fibre rings shall be implemented wherever the network permits. On linear sections of the network, protected links using 4 fibres shall be implemented.

### 3.3.1.3 Service Channel

Service channels shall be provided as a function of the SDH equipment and shall be equipped with Service Channel Muldems that shall provide at a minimum: One voice channel (order wire) with analog interface (0.3 to 3.4 kHz) and one data channel. Both omnibus and selective calling facilities shall be provided. There shall be a facility to extend the line system order-wire to any other system or exchange lines on 2W/4W basis.

### 3.3.1.4 Supervision and Alarms

ISM (In Service Monitoring) circuitry shall be provided as a function of the SDH equipment. Local visual alarm indicators shall be provided on the equipment, as a rack summary alarm panel. Alarms shall be as per ITU-T Standards G.774, G.783 and G.784. Additionally, F2/Q2 interfaces for a local craftsperson terminal interface and remote equipment monitoring is required.

The Equipment shall support collection of at least four (4) external alarms for monitoring and control of station associated devices by the TMN.

### 3.3.1.5 Synchronisation

The equipment shall provide synchronisation as per Table 3-2. One 2MHz synchronisation output from each equipment shall be provided.

### 3.3.1.6 Electrical and Optical I/O Characteristics and General Parameters

Table 3-2 provides the electrical and optical characteristics as well as other general parameters for SDH equipment.

**Table 3-2**
**Electrical and Optical I/O Characteristics and General Parameters**

| | |
|---|---|
| **Optical Wavelength** NOTE (1) | 1310/1550nm |
| **Optical Source** NOTE (2) | Laser |
| **Optical Source Lifespan** | Better than 5 $X10^5$ hours |
| **Optical Fibre Type** | G.652 D |
| **Optical Connectors** | Type FC-PC |
| **Transmission Quality** | Per ITU-T G.821, G.823, G.826 |
| **Source Primary Power** | -48 Vdc |
| **Equipment Specifications** | Per ITU-T G.783 |
| **Tributary, Electrical Interface** | Per ITU-T G.703, 75 Ω |
| **Ethernet Interface** | 10/100 Mbps |
| **SDH Bit Rates** | Per ITU-T G.703 |
| **Optical Interfaces** | Per ITU-T G.957, G.958 |
| **Frame and Multiplexing Structure for SDH** | Per ITU-T G.707 |
| **Synchronization** | Per ITU-T G.813 |
| **Management Functions** | Per ITU-T G.774, G.784 |
| **Protection Architectures** | Per ITU-T G.841 |
| **Built In Testing and Alarms** | Per ITU-T G.774, G.783, G.784 |

**NOTE (1)** Optical wavelength shall be selected considering the characteristics of the optical fibre and the link budget.

**NOTE (2)** **Eye Safety for Laser Equipment:** To avoid eye damage, when a receiver detects a line interruption, it is required that the optical power of the laser shall be reduced to safe limits on the transmitter in the opposite direction as per ITU-T G.958.

**NOTE (3)** In case other than FC-PC connector is provided in the equipment suitable patch cord with matching connectors are to be provided to connect with FODP.

### 3.3.2 Optical Link Performance Requirements

The optical fibre link performance requirements are specified as follows:

#### 3.3.2.1 Link Budget Calculations

The fibre optic link budget calculations shall be calculated based upon the following

criteria:

(1) Fibre attenuation: The fibre attenuation shall be taken to be the guaranteed maximum fibre attenuation i.e. 0.21 dB/Km @1550nm and 0.35 dB/km @1310nm.

(2) Splice loss: Minimum 0.05 dB per splice. One splice shall be considered for every 3 kms.

(3) Connector losses: Losses due to connectors shall be considered to be minimum 1.0 dB per link.

(4) Equipment Parameters: The equipment parameters to be considered for link budget calculations shall be the guaranteed "End of Life (EOL)" parameters. In case, the End of Life parameters are not specified for the SDH equipment, an End of Life Margin of at least 2 dB shall be considered and a similar margin shall be considered for optical amplifiers.

(5) Optical path Penalty : An optical path penalty of at least 1 dB shall be considered to account for total degradations due to reflections, inter symbol interference, mode partition noise and laser chirp.

(6) Maintenance Margin: A maintenance margin of at least 2.5 dB/100Km shall be kept towards cabling, repair splicing, cable ageing and temperature variations etc.

(7) Other losses: Other losses, if any required specifically for system to be supplied shall also be suitably considered.

(8) Dispersion: The fibre dispersion shall be taken to be the guaranteed maximum dispersion i.e. 18 ps/nm.Km @1550 nm & 6 ps/nm.km @ 1310 nm for DWSM fibres.

(9) Bit Error Rate: The link budget calculations shall be done for a BER of $10^{-10}$.

The bidders shall determine the total link loss based on the above parameters and shall submit the system design (including link budget calculations) for each category of fibre optic link during detailed Engineering.

For finalising the FOTS system design & BOQ, above methodology shall be adopted taking into account fibre attenuation, dispersion and splice loss determined during the detailed engineering. Accordingly, additions and deletions from the contract shall be carried out based on unit rates indicated in the contract.

#### 3.3.2.2 Link Performance

The Link performance for ES, SES and BER for the fibre optic links shall correspond to National Network as defined in ITU-T G.826.

#### 3.3.2.3 FODP to SDH Equipment

The Contractor shall be responsible for connectivity between the FODP and the SDH equipment. The Contractor shall provide FC PC coupled patch cords. The location of FODP shall be finalized during survey.

The patch-cord length between the FODP & equipment rack shall be suitably protected from rodents, abrasion, crush or mechanical damage.

### 3.4 Termination Equipment Subsystem

The Termination Equipment Subsystem is defined to include the equipment that interfaces (adapts) the subscriber (user) to the Fibre Optic Transmission System (FOTS). A Functional description of these equipments are as follows:

#### 3.4.1 Functional Description

The transmission network node provides subscriber interface to the transmission network and/or switching/routing. For clarity, the basic functions accomplished at the network nodal points, are described briefly as follows:

Primary Multiplexer shall be used to accomplish subscriber connectivity to the Digital Communication Network. Subscriber Line Units shall provide analog to digital and direct digital conversion to 64 Kbps digital channel. In the CEPT standard hierarchy, thirty (30) such 64 Kbps digital channels shall be Time Division Multiplexed (TDM) resulting in a single 2.048 Mbps (E-1) digital bit stream.

Digital Drop-Insert and Branching Equipment shall be used to digitally interface a small number of channels at spur locations without requiring successive D/A and A/D conversions of the throughput channels.
Digital Cross connect Equipment (DACS) shall be used to provide software controlled dynamic routing/rerouting of the primary (E-1) bit stream as well as the 30 channels of the E1 bit stream.

The equipment shall also have an interface for external 2048 kHz synchronisation signal according to ITU-T Recommendation G.703

### 3.4.2 First Order (Primary) Multiplexing

The Contractor shall be required to provide E-1 Drop & Insert Multiplexer and E-1 Channel Bank primary multiplexing in compliance with the electrical input-output characteristics provided in Table 3-3.

#### 3.4.2.1 Drop & Insert Primary Multiplexing

Drop & Insert primary multiplexing in conformance with CEPT E-1 characteristics shall be required at locations where the subscriber requirement is minimal. The drop and insertion of up to thirty 64 Kbps channels supporting subscriber line units (SLU) shall be required at intermediate locations. The Drop & Insert Muxes supplied shall be performance and card compatible with the Channel Bank Equipment provided so that all Subscriber Line Interface cards are interchangeable.

**Table 3-3**
**CEPT E-1 Standard First Order Multiplexing**
**Electrical Input/Output Characteristics**

| | |
|---|---|
| **Applicable Standards:** | CEPT per CCITT Recommendation G.702, G.703, G.711 and G.712 |
| **Number of Tributaries:** | 30 X 64 Kbps |
| **Alternative Sub-rate Tributaries:** | n X 64 Kbps V.36<br>64Kb/s V.11/V.36 |
| **Output Aggregate Rate:**<br>**Interface Code:**<br>**Impedance:**<br>**Peak Level @ 120 ohm:**<br>**Peak Level @ 75 ohm:**<br>**Maximum Insertion Loss:** | 2.048 Mb/s ± 50 ppm<br>HDB3<br>75 ohm unbalanced<br>3.0 volts ± 10%<br>2.37 volts ± 10%<br>6 db |
| **Signal Waveform:**<br>**Frame Structure:**<br>**Jitter Performance:** | Per CCITT G.703<br>Per CCITT G.742<br>Per CCITT G.823 |
| **Power Supply Voltage:** | -48 vdc |

#### 3.4.2.2 Channel Banks (Mux, Drop/Insert)

User voice and data equipment interfacing requirements are defined at the subscriber line level. Primary multiplexing in conformance with CEPT E-1 characteristics shall be used to provide first order multiplexing of up to thirty 64 Kbps channels supporting Subscriber Line Units (SLUs).

### 3.4.2.3 Subscriber Line Units\Subscriber Line Interface Cards

The terms Subscriber Line Interface Cards and Subscriber Line Units have been used interchangeably throughout the specification. Multiple configurations of SLUs shall be required to provide subscriber to primary multiplexer Bank interfacing for a variety of voice and data communications. In case there are changes in number or type of cards because of changes in channel requirements, the contract price shall be adjusted accordingly.

The SLU interface requirements are discussed in the following subparagraphs:

**(A) Voice Channels**

The voice channel requirement is for (I) 4-Wire E&M trunking in support of PABX trunks & PLC VF and (II) 2-Wire telephonic interfaces. 2 wire SLUs shall be DTMF/TP optioned

for 2-wire loop start or 2-wire GND start. The voice cards shall utilize ITU.T A - law companded PCM G.711, 64 kbits/s encoding. The voice card requirements are indicated in the BoQ in appendices.

**(B) Sub-Channel Data Multiplexing**

For this Project, the RTU data interface to the wideband telecommunications network node shall be defined at the DTE level at low-speed rates of 300, 600 and 1200 baud. The Contractor shall be required to furnish 64 Kbps SLU asynchronous dataplexing for at least 4 selectable low speed DTE interfaces whenever multiple asynchronous data circuits are required.

**(C) Synchronous Data**

The Contractor shall provide a direct DTE interface for synchronous communications at speed of 64Kbps and compatible with CCITT G.703 Kbit/s, V.35 and X.21 interfaces. Data rate selection shall be switch selectable or programmable.

**(D) Nx64 kbps Synchronous Data**

There is also a requirement for N x 64 kbps V.35, X.21 interfaces. The tentative quantities have been identified in the appendices. However the final BOQ shall be worked out during detailed design and contract price shall be adjusted accordingly.

### 3.4.3 Digital Access Cross connect System

The Contractor shall be required to provide Digital Access Cross connect Systems (DACS) capable of switching 16 or more E-1 lines in compliance with the electrical input-output

characteristics provided in Table 2-4. DACSs shall be fully compatible with CEPT E-1 tributary standards.

DACSs shall be provided at locations specified in the appendices and shall be used to establish and reconfigure cross-connections at the tributary level of up to 480 x 64Kb/s channels. DACS E-1 line interface shall be fully capable of accessing each E-1 line.

Within the context of this specification, sizing of DACS system is defined as 4 x n where n is the maximum size of the port switching matrix. Thus a DACS sized as 8 x 16 means that 8 E1 ports are interfaced over a 16 port (E1) matrix.

A DACS system shall consist of the switch matrix, all routing logic and timing circuitry for internally sourced, line derived or externally supplied network timing and full software support.

The DACSs to be provided under this contract shall consist of at least a 16 port switching matrix, with 16 ports equipped, i.e. 16 X 16 size. The DACS shall also be able to switch the signalling of the voice channels along with the voice channels. The DACS shall not use, decrease or block the specified capacity of the switching matrix while switching the signalling. The DACS shall support the Channel Associated Signallling (CAS) and Common Channel Signalling (CCS) both as per ITU-T G. 704.

The DACS shall provide user friendly control and management software. The user shall be able to operate the DACS locally through craft terminal, via an RS-232 interface or remotely under TMN supervisory control.

**Table 3-4**
**CEPT E-1 Digital Access Cross Connect System**
**Required Operating Characteristics**

| | |
|---|---|
| **E-1 Trunk Capacity:** | Minimum 16-Port Switch Matrix<br>Minimum 4-Port I/O per card |
| **Tributary Capacity:** | 30 X 64 Kbps |
| **Compatibility:** | CEPT E-1, CEPT E-1 tributary channel |
| **Frame Delay:** | Minimum < 1 frame<br>Maximum < 2 frames |
| **E-1 Port Interface:**<br>**Interface Code:**<br>**Impedance:**<br>**Peak Level @ 75 ohm:**<br>**Maximum Insertion Loss:** | 2.048 Mb/s ± 50 ppm<br>HDB3<br>75 ohm unbalanced<br>2.37 volts ± 10%<br>6 db |
| **Signal Waveform:** | Per CCITT G.703 |

**Table 3-4**
**CEPT E-1 Digital Access Cross Connect System**
**Required Operating Characteristics**

| | |
|---|---|
| **Frame Structure:**<br>**Jitter Performance:** | Per CCITT G.742<br>Per CCITT G.823 |
| **Synchronisation:** | Internal, external source and synchronized on incoming E-1 |
| **Routing:**<br>**Routing Table Capacity:** | Fully non-blocking tributary to/from E-1 channel<br>Minimum of 9 routing tables for reconfiguration |
| **Supervisory Ports:**<br>**Supervisory Port Interface:**<br>**Interface:** | Serial Com Ports<br>RS-232<br>Standard ASCII ANSI compatible terminal |
| **Supervisory Channel:** | Async data rates, software selectable:<br>speed of 110-9600 bps, odd or even parity<br>7 or 8 bits. |
| **Power Supply Voltage:** | -48 VDC |

### 3.4.3.1 Required DACS Applications

The DACS provided shall be fully capable of implementing standard applications such as "Groom and Fill", Drop & Insert/Bypass, Broadcast and Alternative Routing.

### 3.4.3.2 Menus and Reports

DACSs throughout the network shall be required to function as fully integrated subsystems of the Telecommunications Management Network (TMN).

The DACS software shall provide menu driven management of DACS and shall provide at least the following:

(I) Active Configuration: The user shall be able to modify the current active configuration.

(II) Configuration : The configurations other than the active one shall be listed, edited, viewed, renamed, deleted and activated . Actions shall be allowed manually, upon a carrier failure or specified alarm condition, remotely or on a scheduled basis.

(III) Reports : The user shall have selection of pre formatted specific reports and "Report Options" to be used to select where the next reports will be sent.

(IV) Administration: This shall provide the user, options to control, view and maintain various logs and the DACS software.

(V) Alarms: This shall display Alarm Status on all active ports and shall have an alert mechanism that readily identifies an alarm event to the user through TMN (locally as well as remotely). The alarms shall have different colours based on the importance of the alarm.

## 3.5 MDF, DDF and Cabling

For the purposes of the specification, the contractor shall provide cabling, wiring, DDF patching facilities and MDFs interfacing to the wideband telecommunications system. Equipment and material components for MDF, DDF and cabling are also part of this procurement. It shall be the Contractor's responsibility to provide all cable support required for full supplied equipment interconnection with the MDF and shall be in accordance with communications industry standard practices and the requirements mentioned in the technical specifications.

### 3.5.1 MDF and DDF Patching Facilities

The Contractor shall supply and install all cabling, wiring, connectors, cross connects, Digital Distribution Frames (DDF) and Main Distribution Frames (MDF) associated with the installation and interconnection of equipments procured under this package as follows:

(i) DDFs for termination of new SDH equipment E-1 ports
(ii) Cabling (including connectors) for E1 level connections from DDF to existing SDH equipments, DDF to Existing & new PDH equipments. To the extent possible, existing cable at site shall be used.
(iii) All Ethernet ports shall be terminated with RJ-45 connector. Provision for 100% expansion with connector for terminating additional Ethernet ports shall be provided.
(iv) MDFs for termination of all the subscriber channels at new PDH node
(v) Cabling and connectors required to enable subscriber-to-subscriber circuits over the telecom network. The Line side of the MDF shall be cabled to the Primary Multiplex and the equipment side shall be cabled to the MDF of the assigned subscriber (PLCC, PABX, Telephone at wideband locations etc).
(vi) Any other cables, connections etc required for a fully functional, integrated telecom system.

The connections amongst various equipment such as FOTS, termination equipment and subscriber MDFs etc shall always be routed through DDF and MDF to provide maintenance access.

#### 3.5.1.1 Digital Distribution Frame Functional Requirements

The Contractor shall provide DDF for Digital Signal Cross connect (DSX) Broadband-quality

(better than 20 MHz) patching facilities configured "normally-thru" with Equipment, Line and Monitor Patch Jacks. DDFs shall provide the following basic functions:

(i) "Normally thru" circuit routing
(ii) Circuit rerouting via patch cord assemblies
(iii) Circuit disconnect and termination

All DDFs shall be sized and equipped to support the offered configuration of the provided equipment. Independent Transmit and Receive patch jack assemblies (line and equipment) shall provide for separate transmit and receive single-plug patching. Transmit and receive patch jack assemblies shall be located side-by-side such that dual-plug patch cord assemblies may be used to route both transmit and receive for the same circuit.

#### 3.5.1.2 Main Distribution Frames

The Contractor shall make provision for cross connection of subscriber services to the subscribers utilizing Krone type or equivalent and shall provide full connectivity up to and terminated on the equipment side of the appropriate DDFs and line side of MDFs. The Contractor shall terminate on the equipment side of patching facilities provided by other contracts and shall provide DSX type patching facilities supporting aggregate bit streams (i.e. dataplexers and E-1 Channel Banks). Separate Patch panels or MDFs shall be provided for Data and Voice. All cross

connects shall be accomplished utilizing one, two or three pair patch cords. Patch plugs are permissible for direct one-to-one circuit "cut-thru".

### 3.6 Patch Cords

The Contractor has to supply FC PC coupled Patch cords as described in BOQ. The Patch cord return loss shall be equal to or better than 40 dB and insertion loss equal to or less than 0.5 dB.

### 3.7 Telecommunication Management Network / Network Management System

The Contractor shall provide a Telecommunications Management Network System (TMN) for operational support to the FOTS and associated Termination equipment subsystems. This TMN shall provide the capability to monitor, reconfigure, and control elements of the telecommunications network from a centralized location and at each node of the network where equipment is located. This TMN system shall assist Employer/Owner in the operations and maintenance of the wideband communication resources of the including detection of degraded circuits, system performance, the diagnosis of problems, the implementation of remedial actions and the allocation or reallocation of telecommunications resources and addition/deletion of network elements.

The contractor shall supply preferably a single TMN for all the NEs (Network Elements) such as SDH equipment, Mux, Drop-Insert, DACS etc. In case a single TMN can not be provided for all the NEs, the contractor may supply separate TMNs. Each of the offered TMN shall meet the

requirements indicated in this section. The bidder shall provide details of the offered TMN in the bid.

### 3.7.1 Applicable Standards

The TMN design concept, functional and informational architecture and physical architecture, shall be in compliance with ITU-T Recommendation M.3010.

### 3.7.2 TMN Architecture

The TMN shall provide

a. Collection of Management data from all Network Elements (NEs) supplied under this package. The minimum monitoring and control requirements for the communication equipment shall be as defined in this section.

b. Processing of above management data by using processor(s) located at control Centre and additional intermediate station processor(s), wherever required.

c. Monitoring and control of the NEs as defined below:

   I) TMN system at RLDC (including local operator console) shall support management of all equipments supplied under Central Sector System and monitoring of the entire regional network supplied under this package. At a minimum functions of Network management layer (NML) and Element management layer (EML) as defined in CCITT M3010. The detailed functions are listed in TS.

   II) TMN remote sub-system (including remote operator console) at all the SLDCs shall support management of all equipments supplied under the respective Constituents in this package.

   III) Monitoring and control of NEs using Craft Terminals as defined in this Section .

d. Supervisory monitoring and control of the following station associated devices:

   I) Intrusion Detection Alarms
   II) Power Failure
   III) Fire and Smoke Detection
   IV) Environmental Control (Temperature, Humidity etc.)

e. Communication channel support for TMN System as specified in Technical Specifications (TS).

The supplied TMN system shall be capable of handling all management functions for at least 150% of the final network elements. Further, the centralised TMN system shall also have provision for addition of at least two remote operator consoles. The TMN hardware shall be so designed that failure of a single processor/component (router, switch, converter etc.) shall not

inhibit any of the functionality of the TMN at control centre. The Contractor shall submit for Employer's approval the TMN architecture describing in detail the following subsystems/features:

i. Database used in TMN

ii. Master Processor, server/workstation, LAN, Peripherals and hardware

iii. Software and operating system

iv. Local Consoles/remote consoles

v. Craft Terminals

vi. Data communication between NEs, Remote/Local Consoles and TMN Processor(s)

vii. Routers/Bridges

viii. Expansion Capabilities

f. The offered TMN system shall be capable of integration to other supplier's Network Management System (NMS) upwardly through SNMP North bound interface.The interface shall accommodate all required functionalities to implement OSS but not limited to the following:
   a. Real time forwarding and synchronization
   b. Provisioning of circuits
   c. Upload of network topology
   d. Monitoring of events for topology and circuit changes
   e. Alarm handling

The details shall be finalised and discussed during detailed engineering and the Contractor shall be obliged to provide/share all necessary information and co-ordinate with the implementation vendor of OSS.

### 3.7.3 Management Functions

The TMN shall support following Management functions:

#### 3.7.3.1 Configuration Management

Configuration management is concerned with management, display, and control of the network configuration. Minimum specific requirements that shall be satisfied include the following:

a. Provide tools to establish and maintain the backbone topology and configuration information and provide graphical maps depicting the configurations.

b. Gather descriptive information about the current configuration of the equipment, provide operator displays, and prepare reports.

c. Provide tools for planning, establishing, and changing the static equipment configuration. Provide for changes to the equipment configuration in response to equipment failures, planned upgrades, and operator requests to take equipment offline for testing.

d. Provide verification testing to support new equipment installation.

### 3.7.3.2 Fault Management

Fault management is concerned with detecting, diagnosing, bypassing, directing service restoration, and reporting on all the backbone network equipment, systems, and links. Minimum specific requirements that shall be satisfied include the following:

a. Display equipment status in a consistent fashion regardless of the source of the data on a graphical topological, map-type display. Status shall be displayed through the use of colours on links and nodes as well as through text.

b. Obtain status and detect faults through periodic polling, processing of unsolicited alarms and error events, and periodic testing for connectivity.

c. Maintain an alarm summary of unacknowledged alarm events on the management station display and maintain a log of all received alarms. The operator shall be able to acknowledge and clear alarms individually and as a group. The use of alarm correlation techniques is encouraged to minimize the proliferation of alarms caused by a single, common event. All alarms shall be configurable as critical alarms, major alarms and minor alarms with different colours.

d. Provide the capability to diagnose and isolate failures through analysis of error and event reports and through the use of both on-line and off-line diagnostic tests and display of monitored data.

e. The criteria for fail over shall be configurable as automatic fail over to redundant equipment wherever possible and through operator-initiated actions where automatic fail over is not possible. The status of fail over shall be reported to the NMS.

f. Track network equipment failure history.

### 3.7.3.3 Performance Management

Performance management is concerned with evaluation of the use of network equipments and their capability to meet performance objectives. Minimum specific requirements that shall be satisfied include the following:

a. Provide support for an operator to initiate, collect, and terminate performance metrics under both normal and degraded conditions. For example, BER of each

link, together with other data measured at each node, shall be available on operator request.

b. Monitor point to point & end to end signal quality and history. Provide operator controls to monitor performance of specified events, measures, and resources. Specifically provide displays to permit the operator to:

1. Select/deselect network equipments, events, and threshold parameters to monitor

2. Set monitoring start time and duration or end time

3. Set monitoring sampling frequency

4. Set/change threshold values on selected performance parameters

5. Generate alarm events when thresholds are exceeded.

6. Set multiple thresholds on certain performance parameters. Alarm categories include as a minimum a warning and a failure.

7. Calculate selected statistical data to measure performance on selected equipment based on both current and historical performance data maintained in performance logs. Performance data provided is limited to what is available from the equipment Contractors.

8. Provide graphical displays of point to point and end to end current performance parameter values. Provide tabular displays of current, peak, and average values for performance parameters.

9. Generate reports on a daily, weekly, monthly, and yearly basis containing system statistics.

### 3.7.3.4 Security Management

The TMN shall be provided with security features to limit access to monitoring and control capabilities to only authorized personnel. One access level of System Administrator and at least two levels of operator access shall be provided - read (view) only, and write (configure). The system administrator shall be able to create, define and modify operators with different access levels, network domains and perform all kind of maintenance and up gradation of the TMN system. With "read only" access level, network parameters should only be viewed. Access to database maintenance, command control and test functions shall be available with "write " access level. Means shall be provided to ensure only one authorized user has write capability for a selected domain of the network. It shall be possible to define multiple domains for purposes of monitoring and control.

Human error and conflict detection are also required. Such errors and access violations shall be reported to the offending user as error messages and warnings.

### 3.8 Communication Channel Requirement and Integration

Communication requirements for TMN system have not been considered in Appendices and the Contractor shall provide these as a part of TMN system. The Contractor shall provide all required interface cards / devices, LAN, routers/bridges, channel routing, cabling, wiring etc. and interfacing required for full TMN data transport.

The TMN data transport shall utilize the wideband communications transmission system service channel in the overhead whenever possible. This will provide inherent critical path protection

Should the configuration requirements dictate multiple TMN station processors, the TMN Master Station shall require bidirectional data transport with its station processor(s). This communications interfacing shall be via critically protected data channels. It shall be the Contractor's responsibility to provide for and equip all necessary critically protected TMN data channel support.

In case supervisory channels are not available, the Contractor shall provide suitable interfaces in their supplied equipment for transport of TMN data. The Contractor shall also be responsible for providing suitable channels with appropriate interfaces to transport the TMN data.

The NMS information of existing PDH & SDH system shall be transported through the new communication network, wherever required, up to the NMS location. The NMS information of the new SDH & PDH system being procured under the package shall be transported through the existing communication network using 64 kbps/2Mpbs (G.703) interfaces. Any hardware required for above interfacing shall be provided by the Contractor.

The bidders shall describe in the proposal the TMN data transport proposed to be used by the bidder in detail including capacity requirements and various components/equipment proposed to be used.

### 3.9 Craft Terminal

Each equipment (SDH equipment, Mux, Drop/Insert and DACS etc.) on the fibre optic communication network shall include provision for connecting a portable personal computer (PC) to be known as craft terminal to support local commissioning and maintenance activities. Through the use of this PC and local displays/controls, the operator shall be able to:

a. Change the configuration of the station & the connected NEs.
b. Perform tests
c. Get detailed fault information

The craft terminal shall be connected to the interface available in the communication equipment. Portable (laptop) computers (Craft terminals), each complete with necessary system and application software to support the functions listed above, shall be supplied to the employer as per BOQ given in the appendices.

## 3.10 Hardware Requirements

### 3.10.1 Master Processor, Server/Workstation and Craft Terminal

The server/workstation and craft terminal shall have suitable processor(s) which shall be sufficient to meet all the functional requirement and expansion capabilities stipulated in this specification. Only reputed make like Dell, IBM, HP, Compaq make shall be supplied.

The server shall have minimum configuration of 3GHz for CISC based or 1.6GHz for RISC based processor, 2GB RAM, DVD-ROM drive, redundant 80 GB internal Hard Disk Drive, 101-Enhanced style keyboards, mouse, parallel, serial, USB(2.0) ports and hot swap redundant power supply. VDUs shall be 17" TFT active matrix color LCD with a minimum resolution of 1024 X 768. Appropriate network drive card shall also be provided wherever required. However, the internal hard disk drive for the server shall be redundant and all the data shall be mirrored. Further, the TMN software shall support data mirroring on redundant disk drives.

The workstation shall have minimum configuration of 2.4GHz for CISC or 1.4GHz for RISC based processor, 1GB RAM, DVD-RW drive, 160 GB Hard Disk Drive, 101-Enhanced style keyboards, mouse, parallel, serial and USB (2.0) ports. VDUs shall be 19" TFT active matrix color LCD with a minimum resolution of 1024 X 768. Appropriate network drive card shall also be provided wherever required.

CPU enclosures shall be desktop type and shall include available expansion slots except for the Craft Terminal which shall be a laptop. The craft terminal shall have minimum configuration of 2.4 GHz, 2 GB RAM, 256 MB VRAM, DVD RW drive, 160 GB Hard Disk Drive, keyboard, mouse/trackball etc., parallel, serial/USB (2.0) ports to accommodate printers, and Internal/external Data/Fax modem and a battery back-up of at least 60 minutes. VDUs shall be 15" TFT active matrix color LCD with a minimum resolution of 1024 X 768.

### 3.10.2 Peripherals and hardware

TMN system shall be provided with laser printer. The laser printer shall have a minimum print speed of 17 pages per minute and a minimum resolution of 1200 x 1200 dpi. The laser printer shall have parallel and LAN ports for connecting to TMN system.

The laser printer under this specification shall be black & white and include print enhanced buffering to prevent loss of print data in the event of a print failure.

### 3.10.3 Local/Remote Operator Consoles

The Contractor shall provide operator consoles sized and equipped to support the subsystem(s) furnished and in compliance with the specification. The console shall provide hardware interfacing for the TMN users to the software operating support systems. At a minimum, a console shall include the hardware similar to a workstation.

### 3.10.4 Power Supplies

The TMN system shall use 220 volts 50 Hz A.C or -48 volt D.C as available at site for its operation as available at site.

## 3.11 General Software/Firmware Requirements

Due to various alternative design approaches, it is neither intended nor possible to specify all software and firmware characteristics. It is the intent herein to provide design boundaries and guidelines that help to ensure a demonstrated, integrated program package that is maintainable and meets both hardware systems requirements and the customer's operational requirements.

### 3.11.1 Operating System Software

Operating system software shall be provided to control the execution of system programs, application programs, management devices, to allocate system resources, and manage communications among the system processors. The contractor shall make no modifications to the OEM's operating system, except as provided as USER installation parameters.

### 3.11.2 Applications Software

All applications software shall be written in a high-level programming language unless developed using industry proven application programs and development tools provided with the system. The contractor shall make no modifications to the applications program except as provided as USER development tools.

### 3.11.3 Software Utilities

A utility shall be provided to convert all reports into standard PC application formats such as excel.

### 3.11.4 Revisions, Upgrades, Maintainability

All firmware and software delivered under this specification shall be the latest field proven version available at the time of contract approval. Installed demonstration for acceptance shall be required. All firmware provided shall support its fully equipped intended functional requirements without additional rewrite or programming.

All software shall be easily user expandable to accommodate the anticipated system growth, as defined in this specification. Reassembly recompilation or revision upgrades of the software or components of the software, shall not be necessary to accommodate full system expansion.

Software provided shall be compliant with national and international industry standards.

### 3.11.5 Database(s)

The contractor shall develop all the databases for final wideband network following the global acronyms for all stations. Database(s) to be provided shall contain all structure definitions and data for the integrated functional requirements of TMN system.

TMN operator Groups shall share the same virtual database. This means that they shall share the same database and database manager, whether or not physically separate databases are maintained.

### 3.11.6 Help

All applications shall be supported by USER accessible HELP commands that shall assist the user in the performance of its tasks. HELP commands for an application shall be available to the user from within the active application and shall not interfere with the activities of the application.

**----------End of the Section----------**

# Section-04

# DC Power Supply System

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## Section-04

## DC Power Supply System

In order to provide reliable power supply to computer loads & communication equipment at various locations, the 48 V DC power supply system is to be provided as a part of this project. This section describes the technical requirement of DC power supply & associated Battery.

The DC Power Supply system shall be capable of meeting the load requirements for various Telecom equipments and other associated equipment located indoor, i.e. at the substations and control centers. The required load (in Amps) for each location alongwith the Battery capacity is indicated in the Appendix, BoQ. The rating of offered SMPS modules shall meet Employer's requirements of DCPS system as stipulated in the BoQ.

The field site DC Power supply system shall have a single DC power supply system as per conceptual configuration diagram given in Fig.4-1, shall be supplied.

Surge protection devices shall be installed in the DCPS panel to provide adequate protection against current and voltage transients introduced on input mains AC due to load switching and low energy lightning surges. These protection devices shall be in compliance with IEC 61312, IEC 61024 and VDE 0100-534 for following surges:

It shall be provided with Class 'B' & 'C' type surge protection device. The device must be provided with Class B type lightning current arrester (Switching Type) with a discharge current capacity of at least 50 kA, 10/350 µs, and Class C type surge arrester (linear device) as per IEC 61643-1. The blind spots shall be avoided in accordance to IEC 61312. The Class 'C' surge protection device should be pluggable type, equipped with features of thermal disconnection, & health indication and potential free contacts for surge arrestors connected between phase & neutral.

The surge protection device shall comply to IEC 61643.

a) Lightning Electromagnetic impulse and other High Surges (Class B):

| **Between** | **Requirement** |
|---|---|
| Ph & N | $I_{imp} \geq$ 50 kA, 10/350 µS for each phase |
| N & PE | $I_{imp} \geq$ 100 kA, 10/350 µS |

$I_{imp}$= Value of Lightning Impulse Current
Rated input voltage of Class 'B' surge arrestors shall not be less than 320 V.

b) Low Voltage Surges (Class C)

| **Between** | **Requirement** |
|---|---|
| Ph & N | $I_n \geq$ 10 kA, 8/20 µS for each phase |

N & PE $I_n \geq 20$ kA, 8/20 μS

$I_n$= Value of Nominal Discharge Current.

Voltage rating of Class 'C' surge arrestors shall be minimum 320 V.

The Class'B' & 'C' Surge protection devices shall work in tandem and in perfect co-ordination to give complete protection to the DCPS system against lightning and switching surges.

## 4.1 General Technical Requirements for SMPS based DC power supply units

SMPS based DC power supply system is to be used in Auto Float-cum-Boost Charge mode as a regulated DC Power source. DCPS system is to be installed indoors and shall be provided with IP21 panels. The System shall consist of the following:

SMPS modules

(a) Controller module to control and monitor all DCPS modules.

The Panel, Distribution/Switching arrangement shall be provided for the ultimate system capacity. Ultimate System capacity is defined as 150% of the present capacity specified in **Appendix B,** BOQ. The ultimate capacity is over and above the requirement of redundancy wherever specified. All factory wiring for the panel shall be for the ultimate capacity so that only plugging-in of SMPS module shall enhance the DC power output.

The size of fuses, MCBs, switch, bus etc shall be suitable for the ultimate capacity.

The system shall be sufficiently flexible to serve any load depending on manufacturer's design, rating and number of SMPS modules used in panel and system configuration. To cater for higher load requirements, same type of SMPS modules mounted in the same rack or different racks shall be capable of working in parallel load sharing arrangement. The SMPS modules of DCPS system shall be suitable for operation from single phase A.C. mains/DG set supply. However, the input AC mains supply to DCPS system shall be 3-phase, 4 wire which shall be evenly distributed among all the offered SMPS modules.

### 4.1.1 Operational/Component Requirements

The basic modules shall operate at specified ratings and conform to requirements stipulated in this specification. The DCPS system shall meet requirement of the latest TEC specification / IEC/BS for other parameters as applicable. The component parts of the equipment shall be of professional grade of reputed manufacturer to ensure prompt and continuous service and delivery of spare parts. The component shall confer to relevant IEC/IS standards. The contractor shall obtain Employers approval of major component before procurement of the same.

### 4.1.2 Wiring

All insulated conductors except those within the confines of a printed circuit board assembly shall be of the rating enough to withstand the maximum current and voltage during fault and overload. All insulated conductors/cables used shall conform to IS 1554 or equivalent international standard.

All wiring shall be neatly secured in position and adequately supported. Where wires pass through any part of metal panel or cover, the hole through which they pass shall be suitably secured.

### 4.1.3 Bus Bars

High conductivity Cu bus bar shall be provided and shall be sized to take care of the current of ultimate DCPS system capacity for which it is designed. However, it shall not be less than 25mm X 5mm.

### 4.1.4 Earthing

Two earth terminals shall be provided in the frame of the system. The Contractor shall connect these earth terminals to the earth bus. All modules and devices shall be connected to these earth terminals. The hinged door, if provided shall be connected to the panel with braided Cu at two points at least.

### 4.1.5 Finish and Painting

The finish of Steel/Aluminum alloy structure and panels shall conform to relevant IS specification (or equivalent international specifications). The colour code scheme for Panel & Door (if provided) shall be decided during detailed engineering.

### 4.1.6 Marking and Labelling of Cables

The Contractor shall propose a scheme for marking and labeling the inter panel cables by Halogen & Silicon free labels of polyamide ensuring scratch proof labelling with the use of solvent free ink & latest UV Technology making it environment friendly printing with a WIPE RESISITANCE according to DIN EN 61010-1/VDE 0411-1 and get it approved from the Employer. A cabling diagram, screen printed or any other better arrangement ensuring better life expectancy shall be placed in the inside of the front door or any other convenient place for ready reference of the maintenance staff.

### 4.1.7 Name Plate

A name plate etched, engraved, anodized or any other better arrangement ensuring better life expectancy shall be suitably fixed on each panel /module and contain at least the following information :

(a) Specification Number
(b) Type of the Unit
(c) Manufacturer's Name and identification
(d) Model No
(e) Unit serial No
(f) Input voltage and phase
(g) Output Voltage and Current
(h) Year of manufacture

### 4.1.8 System and Panel Configuration

The mechanical and electrical requirements of the Panel are described as below:

### 4.1.9 System Configuration

The SMPS modules shall be accommodated in panels. The system shall employ a modular configuration to provide flexibility, keeping in view the future load requirements of DC Power. The system shall be configured for ultimate capacity as brought out in Section 4.1. The Control, Monitoring, Alarm arrangement and DC & AC distribution shall be provided suitably in the panel.

The SMPS modules shall be provided as per the load requirement stipulated in the Appendix, BOQ. The DCPS system shall comprise of N+2 Modules. In case of DCPS system having N=1, the SMPS shall comprise of N+1 modules. Here N refers to number of SMPS modules to meet the load requirements specified in the Appendix, BOQ and battery charging current. The current rating of each module shall be considered as output current of the SMPS module at nominal voltage (48V).

Total current = load current + battery charging current

Where, battery charging current is equal to the 20 % AH of the battery supplied.

$$N = \frac{\text{Total Current}}{\text{Current rating of each SMPS module at 48 V}}$$

The Distribution/switching/Alarm unit shall be provided for the ultimate system capacity. All AC, DC or control/alarm cabling/wiring shall be pre-wired for the ultimate capacity so that mere plugging-in of SMPS module shall add to the DC power output.

It shall be possible to easily mount/remove the modules from the front side of the panel. The SMPS modules/SMPS module sub-racks shall be designed to slide into the panels and fixed securely by a suitable mechanical arrangement.

### 4.1.10 Constructional Features of Panel

Panel (Enclosure) shall be freestanding type of design, in case of specifically it is not mentioned in the relevant section. Cable entry shall be from the bottom/top of the enclosures (to be finalized during detailed engineering). For the enclosures/panel, the front door (if provided) shall not be wider than 80 cm and rear door may be of hinged or removable type with locking as per standard design of the manufacturer. Keyed locking is required with identical keys for all enclosures. The enclosures shall not exceed 220 cm in height. The thickness of the structural frames and load bearing members shall be minimum 2.0 mm and for others shall be minimum 1.6 mm. The panels/boards shall be equipped with necessary cable gland plates. The Contractor shall state the type, size, and weight of all enclosures and indicate the proposed manner of installation. The degree of protection of DCPS enclosures shall preferably be IP21, however in case no door is provided then the top of the enclosure/panel shall be fully covered except for proper ventilation and bus bar or cable entries.

Wiring within panel shall be neatly arranged and securely fastened to the enclosure by non-conductive fasteners. Wiring between all stationary and moveable components, such as wiring across hinges or to components mounted on extension slides, shall allow for full movement of the component without binding or chafing of the wire. Conductors in multi conductor cables shall be individually colour coded, and numbered at both ends by Halogen & Silicon free labels of polyamide ensuring scratch proof labelling with the use of solvent free ink & latest UV Technology making it environment friendly printing with a WIPE RESISITANCE according to DIN EN 61010-1/VDE 0411-1within enclosures.

The enclosures shall be painted inside and outside. The finish colour of all enclosures shall be an aesthetically pleasing and shall be approved by the Employer. Further, finish colour of external surfaces shall be preferably of same colour for all enclosures/panels.

Each panel shall be supplied with 240 VAC, 50Hz single-phase sockets with switch and lighting lamp for panel illumination.

The manufacturer so as to ensure the uninterrupted use of the equipment shall do proper thermal engineering of hardware design. The Panel shall be designed to allow cooling preferably by natural convection. The Contractor shall submit detail design of proposed Panel/enclosure and heat dissipation calculations during detailed engineering. Forced cooling is permitted (DC Fans are permitted in the Panel or SMPS module) for equipment mounted indoors (buildings/rooms/shelters). If cooling is provided at Panel level it shall be provided with additional fan with facility for manual switch over. Proper filtering shall be provided to control dust ingress. There shall be an arrangement for automatic Switching-OFF of fans during AC input failure. The required individual modules may be separated by air baffle to provide effective convection. The manufacturer shall also ensure that the failure of fan does not cause any fire hazards. The failure of any of the fans shall draw immediate attention of the maintenance staff.

### 4.1.11 Electrical Requirements:

**AC input supply**: The nominal input frequency is 50 Hz, which may vary from 47.5-52.5Hz. The input voltage shall be as mentioned below:

**Field Site Application** – Three phase/4Wire (Nominal 415/240 V): 415 + 10 % - 15%. However, at site the voltage may vary from 160V to 300V (Ph-N). An Auto-Mains Changeover unit shall be provided for each field site DC power supply system. The Auto-Mains Changeover unit shall accept input from two AC sources and extend any one of the available healthy sources to the DC Power supply system.

**Control Centre Site Application** – Three phase/4Wire (Nominal 415/240 V): 415 + 10 % - 15%. However, at site the voltage may vary from 160V to 300V (Ph-N).

The suitable HVD (High Voltage Disconnector) Protection shall be provided at input of each DCPS system. This HVD protection shall protect the SMPS modules of DCPS system against the sustained over voltage at the input.

There shall be an automatic arrangement for shutting off of the SMPS module whenever the input voltage is beyond the specified operating limits with suitable alarm indication. The SMPS module shall resume normal working automatically when the input is restored within the working limits. Hysteresis within specified working limits shall not cause shutting down of the SMPS. A tolerance of ±5V may be acceptable for protection & alarm operation.

### 4.1.12 DC output Characteristics of Modules

The module shall be capable of operating in "Auto Float-cum-Boost Charge" mode depending on the condition of the battery sets being sensed by the Control unit.

(a) The float voltage shall be continuously adjustable & pre-settable at any value in the range of –48 to –56V or as per battery manufacturer recommendations either at the module or may be set from the common controller configuration. Further, the prescribed float voltage setting shall be based on recommendations of the battery supplier.

(b) In Boost charge mode, DCPS shall supply battery & equipment current till terminal voltage reaches set value, as recommended by the battery supplier & shall change over to constant voltage mode

(c) The DC output voltage variation shall not be more than 2% for load variation from 25% load to full load.

### 4.1.13 Current Limiting (Voltage Droop)

The current limiting (Voltage Droop) shall be provided in DCPS SMPS modules in float and boost charge modes of operation. The float/boost charge current limiting shall be continuously adjustable between 50 to 100% of rated output current for output voltage range of –44.4 volts to –56 Volts or as per manufacturer's specified catalogue.

The float and boost charge current limit adjustment shall be provided in the DCPS system. The SMPS modules shall be fully protected against short circuit. It shall be ensured that short circuit

does not lead to any fire hazard.

### 4.1.14 Soft/Slow Start Feature

Soft/Slow start circuitry shall be employed such that SMPS module input current and output voltage shall reach their nominal value within 10 seconds.

The maximum instantaneous current during start up shall not exceed the peak value of the rectifier input current at full load at the lowest input voltage specified.

### 4.1.15 Voltage overshoot/Undershoot

The requirements of (a) to (c) given below shall be achieved without a battery connected to the output of SMPS modules.

(a) The SMPS modules shall be designed to minimize DC output voltage Overshoot/Undershoot such that when they are switched on the DC output voltage shall be limited to ± 5% of the set voltage & return to their steady state within 20 ms for load variation of 25% to 100%.

(b) The DC output voltage overshoot for a step change in AC mains as specified in clause 4.3.12 Electrical Requirements shall not cause shut down of SMPS module and the voltage overshoot shall be limited to ± 5% of its set voltage and return to steady state within 20ms.

(c ) The modules shall be designed such that a step load change of 25 to 100% and vice versa shall not result in DC output voltage Overshoot/Undershoot of not more than 5% and return to steady state value within 10 ms without resulting the unit to trip.

### 4.1.16 Electrical Noise

The Rectifier (SMPS) Modules shall be provided with suitable filter at output with discharge arrangements on shut down of the modules. The Psophometric Noise (e.m.f weighted at 800Hz) with battery connected across the output should be within 2 mV at full load at nominal input AC supply. For test purposes, this shall be taken as equivalent to 4mV when the battery is not connected and in accordance to ITU-T Rec. O.41.

Voltage at the output of the Rectifier (SMPS) module, without battery connected, shall not exceed 300 mV at the switching frequency measured by an Oscilloscope of 50/60 MHz bandwidth (Typical).

### 4.1.17 Parallel Operation

SMPS modules shall be suitable for operating in parallel with one or more modules of similar type, make and rating, other output conditions remaining within specified limits.

The current sharing shall be within ± 10% of the average current per rectifier module individual capacity of each rectifier module in the system (mounted in the same or different Panels) when loaded between 50 to 100% of its rated capacity for all other working conditions.

### 4.1.18 Protection

The SMPS module, which has failed (for any reason) shall be automatically isolated from the rest of the modules and an alarm shall be initiated for the failure.

### 4.1.19 DC Over voltage protection

DCPS shall be fitted with an internal over voltage protection circuit.

In case output DC voltage exceeds –57V or as per the recommendations of the manufacturer of batteries, the over voltage protection circuit shall operate & shut off the faulty module. A tolerance of ± 0.25V is permitted in this case.

Shutting off of faulty SMPS module shall not affect the operation of other SMPS modules operating in the Panel. Operation of over voltage shut down shall be suitably indicated and extended monitoring/control unit. The circuit design shall ensure protection against the discharge of the Battery through the SMPS module in any case. The over voltage protection circuit failure shall not cause any safety hazard.

### 4.1.20 Fuse/Circuit Breakers

Fuses or miniature circuit breakers (MCB) shall be provided for each SMPS module as follows:

1. Live AC input line
2. Control Circuit

All fuses/circuit breaker used shall be suitably fault rated.

### 4.1.21 AC Under/Over Voltage Protection

AC input Under/Over voltage protection shall be provided as per clause 6.1.12 for Electrical Requirements. The DC side of the SMPS should also be provided with surge protection device to protect the SMPS in case of transients being generated by the loads or due to induction in the DC line from the AC line running parallel together. The Surge protection device should be able to discharge a current of at least 10 kA of 8/20 µs (Class 'C' surge arrestor), pluggable and should have indication to show its health to facilitate the replacement on fault condition.

.

### 4.1.22 Over Load/Short Circuit Protection

The SMPS shall be protected for Over load/Short circuit as per clause 6.1.14 Current Limiting (Voltage Droop).

### 4.1.23 Alarms and indicating lamps

Visual indications/display such as LEDs, LCDs or a combination of both shall be provided on each SMPS module for detection of SMPS module failure.

### 4.1.24 Termination

Suitable termination arrangements shall be provided in the panel for termination of inter cubicle cables from other equipment such as Employers ACDB, Telecom and other associated equipments and alarm cables. All the termination points shall be easily accessible from front and top. AC and DC terminals shall be separated by physical barriers to ensure safety. All the terminals except AC earth shall be electrically isolated.

### 4.1.25 DC Terminations

All terminations including through MCBs shall be through lock and screw type terminations. Load and batteries shall be connected to DCPS through appropriate MCBs. The isolation of any of the battery from the load shall create an alarm. DC distribution shall be provided with adequate no. of feeders with appropriate MCBs (6 Amp thru 32 Amp) for termination of the loads. Actual rating of the MCBs shall be finalized during the detail engineering. The no. of feeders shall be minimum 10 (ten) nos.

DC distribution may be done either on wall mounted panel or on the DCPS panel. The proper rated MCB shall be provided at the combined output of the SMPS modules (if not provided at each SMPS module). All the AC, DC and Control/alarm cabling shall be supplied with the Panel. All DC +ve and –ve leads shall be clearly marked. All conductors shall be properly rated to prevent excessive heating.

### 4.1.26 Earthing Cables

Earthing cables between equipment and grounding bus bars shall be minimum size 70 $mm^2$ stranded conductors copper/copper strip, rated at 300 volts. All hinged doors shall be earthed through flexible earthing braid. Signal and Safety earthing shall be provided separately.

### 4.1.27 Alarms

Following Visual indications/display such as LEDs, LCDs or a combination of both shall be provided to indicate :

Functional Indications for local monitoring:

a) Mains available (not mandatory if provided at module level)
b) DCPS/SMPSs in Float charge Mode
c) DCPS/SMPSs in Boost Charge Mode

Alarm Indication for local monitoring:

a) Load Voltage High /Low

b) DCPS module/SMPS fail
c) Mains out of range
d) System Over Load
e) Mains "ON"/Battery Discharge
f) Battery fail/isolated

All the protections/alarms shall be within tolerance of 0.25V in case of DC voltage, 1% in case of DC current and ± 5V for AC voltage

Alarm Indication for remote monitoring:

a) Input AC mains supply fail alarm
b) Battery low voltage (Pre cut off) alarm
c) DCPS module fail

Potential free Contacts in two numbers for each of the above remote monitoring alarms (one for remote alarm interfaced through communication equipments and one redundant for local monitoring at suitable location) shall be provided. All these potential free contacts are to be wired and terminated at the suitable location for interfacing purpose.

### 4.1.28 Digital Meters/Display Unit

There shall be provision to monitor the following parameters through digital meters or digital display units:

(a) Input AC voltage.
(b) Out put DC voltage
(c) Output DC current of charger
(d) Battery current
(e) Load current.

The Digital display of meters or LCD based display unit shall be with minimum $3^1/_2$ digital display of height 12mm and shall have accuracy 1.5% or better.

## 4.2 Cabling & Enclosure Requirements

The contractor shall supply, install and commission all power cables, control cables, network interface cables and associated hardware (lugs, glands, cable termination boxes etc.) as required for all equipment. The contractor shall be responsible for Cable laying and termination at both ends of the cable. The Contractor shall also be responsible for termination of feeder cables at contractor's equipment end including supply of suitable lugs, glands, terminal blocks & if necessary cable termination boxes etc. All cabling, wiring, and interconnections shall be installed in accordance with the following requirements.

### 4.2.1 Power Cables

All external power cables shall be stranded Aluminium conductor, armoured XLPE/PVC insulated and sheathed, 1100V grade as per IS 1554 Part-I.

### 4.2.2 Enclosure/Panel Earthing

Each enclosure shall include suitable earth networks within the enclosure. Earth network shall be a copper bus bar, braid or cable inside enclosures.

The safety earth network shall terminate at two/more studs for connecting with the earthing grid. Safety earthing cables between equipment and enclosure grounding bus bars shall be minimum size 6 sq. mm, stranded copper conductors, rated at 300 volts. All hinged doors (if provided) shall be earthed through flexible earthing braid.

For all enclosures requiring AC input power, the green earthing wire from the AC input shall be wired to the safety earthing stud. The Contractor shall provide all required cabling between enclosures for earthing. The contractor shall connect safety and signal earths (as applicable) of each enclosure to the Employer provided nearest earth grid/earth riser through suitable 50X6 sq. mm. GI strips or suitably sized copper cable.

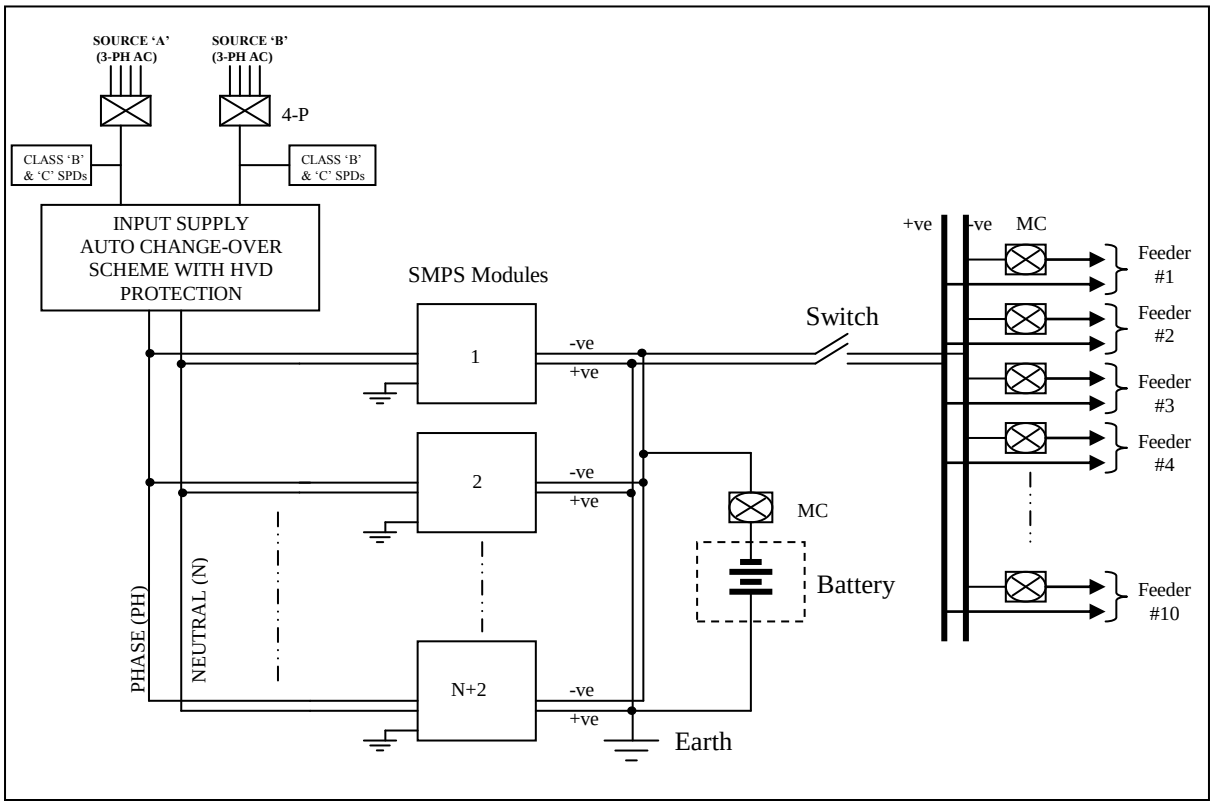
The signal earthing network shall terminate at a separate stud connection, isolated from safety ground. The stud connection shall be sized for an external earthing cable equipped with a suitable lug.

All earthing connections to equipment shall be made directly to each equipment chassis via earthing lug and star washer. Use of the enclosure frame, skins, or chassis mounting hardware for the earthing network is not acceptable.

## 4.3 Temperature Compensation for Battery

There shall be provision for monitoring the temperature of battery and consequent arrangement for Automatic temperature compensation of the SMPS output voltage to match the battery temperature dependant charge characteristics. The output voltage of the rectifier in Float/Charge operation shall decrease or increase at the rate of 72 mV (3mV/cell, 24 cell battery) per degree increase or decrease in temperature over the set voltage or as may be recommended by the VRLA Battery supplier. A tolerance of +/- 5mV may be acceptable over the specified rate of 72 mV/degree C. The output voltage shall decrease till the open circuit voltage of the battery is reached. The open circuit voltage range shall be settable between 2.1V/cell to 2.2V/cell. The increase in output voltage due to decrease in temperature has been taken care of by the tripping of the unit due to output voltage high (57V) protection. Failure of temperature compensation circuit including sensors shall create an alarm and shall not lead to abnormal change in output voltage. The nominal distance between the battery & DCPS system may be 20 metres. The Contractor shall provide the necessary sensor and cord for the purpose with DCPS system.

## FIG. 4-1 : CONCEPTUAL CONFIGURATION OF DC POWER SUPPLY (DCPS) SYSTEM (For Field Sites Locations)



## 4.4 Battery Requirements

### 4.4.1 Valve Regulated Lead Acid (VRLA) maintenance free Battery

The contractor shall supply Valve Regulated Lead Acid (VRLA) maintenance free Battery. Each battery set shall have sufficient capacity to maintain output at full rated load as indicated in BOQ in **Appendix**. The battery shall be capable of being recharged to 90% State of Charge (SOC) from the fully discharged condition (1.75V/cell) within 8 hrs. In all cases, the battery is normally not allowed to discharge beyond 80% of rated capacity (80% DOD) at 10 hours rate of discharge.

The supplier, supplying the cells/batteries as per this document shall be responsible to replace/repair free of charge, the battery/cell becoming faulty, owing to defective workmanship or material as per the provisions of the bid document

#### 4.4.1.1 Constructional Requirements

The design of battery shall be as per field proven practices. Partial plating of cells is not permitted. Paralleling of cells externally for enhancement of capacity is not permitted. Protective transparent front covers with each module shall be provided to prevent accidental contact with live module/electrical connections.

#### 4.4.1.2 Containers

The container material shall have chemical and electro-chemical compatibility and shall be acid resistant. The material shall meet all the requirements of VRLA batteries and be consistent with the life of battery. The container shall be fire retardant and shall have an Oxygen Index of at least 28%. The porosity of the container shall be such as not to allow any gases to escape except from the regulation valve. The tensile strength of the material of the container shall be such as to handle the internal cell pressure of the cells in the worst working condition. Cell shall not show any deformity or bulge on the sides under all working conditions. The container shall be capable of withstanding the rigours of transport, storage and handling. The containers shall be enclosed in a steel tray.

#### 4.1.1.3 Cell Covers

The cell covers shall be made of suitable material compatible with the container material and permanently fixed with the container. It shall be capable to withstand internal pressure without bulging or cracking. It shall also be fire retardant. Fixing of Pressure Regulation Valve & terminal posts in the cover shall be such that the seepage of electrolyte, gas escapes and entry of electro-static spark are prevented.

#### 4.4.1.4 Separators

The separators used in manufacturing of battery cells, shall be of glass mat or synthetic material having high acid absorption capability, resistant to sulphuric acid and good insulating properties. The design of separators shall ensure that there is no misalignment during normal operation and handling.

#### 4.4.1.5 Pressure Regulation Valve

Each cell shall be provided with a pressure regulation valve. The valve shall be self re-sealable and flame retardant. The valve unit shall be such that it cannot be opened without a proper tool. The valve shall be capable to withstand the internal cell pressure specified by the manufacturer.

#### 4.4.1.6 Terminal Posts

Both the +ve and –ve terminals of the cells shall be capable of proper termination and shall ensure its consistency with the life of the battery. The surface of the terminal post extending above the cell cover including bolt hole shall be coated with an acid resistant and corrosion retarding material. Terminal posts or any other metal part which is in contact with the electrolyte shall be made of the same alloy as that of the plates or of a proven material that does not have any harmful effect on cell performance. Both +ve and –ve posts shall be clearly and unambiguously identifiable.

#### 4.4.1.7 Connectors, Nuts & Bolts, Heat Shrinkable Sleeves

Where it is not possible to bolt the cell terminals directly to assemble a battery, separate non-corroding lead or copper connectors of suitable size shall be provided to enable connection of the cells. Copper connections shall be suitably lead coated to withstand corrosion due to sulphuric acid at a very high rate of charge or discharge.

Nuts and bolts for connecting the cells shall be made of copper, brass or stainless steel. Copper or brass nuts and bolts shall be effectively lead coated to prevent corrosion. Stainless steel bolts and nuts can be used without lead coating.

All inter cell connectors shall be protected with heat shrinkable silicon sleeves for reducing the environmental impact including a corrosive environment.

#### 4.4.1.8 Flame Arrestors

Each cell shall be equipped with a Flame Arrestor to defuse the Hydrogen gas escaped during charge and discharge. Material of the flame arrestor shall not affect the performance of the cell.

#### 4.4.1.9 Battery Bank Stand

All batteries shall be mounted in a suitable metallic stand/frame. The frame shall be properly painted with the acid resistant paint. The suitable insulation shall be provided between stand/frame and floor to avoid the grounding of the frame/stand.

### 4.5 Capacity Requirements

When the battery is discharged at 10 hour rate, it shall deliver 80% of C (rated capacity, corrected at 27ºCelcius) before any of the cells in the battery bank reaches 1.85V/cell.

The battery shall be capable of being recharged from the fully exhausted condition (1.75V/cell) within 8 hrs. All the cells in a battery shall be designed for continuous float operation at the specified float voltage throughout the life. Float voltage of each cell in the string shall be within the average float voltage/cell $\pm$0.05V band.

The capacity (corrected at 27ºCelcius) shall also not be less than C and not more than 120% of C

before any cell in the battery bank reaches 1.75V/cell. The battery voltage shall not be less than the following values, when a fully charged battery is put to discharge at C/10 rate:

(a) After Six minutes of discharge : 1.98V/cell
(b) After Six hours of discharge : 1.92V/cell
(c) After 8 hours of discharge : 1.85V/cell
(d) After 10 hours of discharge : 1.75V/cell

Loss in capacity during storage at an average ambient temperature of 35º Celsius for a period of 6 months shall not be more than 60% and the cell/battery shall achieve 85% of its rated capacity within 3 charge/discharge cycles and full rated capacity within 5 cycles, after the storage period of 6 months. Voltage of each cell in the battery set shall be within $\pm$0.05V of the average voltage throughout the storage period. Ampere hour efficiency shall be better than 90% and watt hour efficiency shall be better than 80%.

### 4.6 Expected Battery Life

The battery shall be capable of giving more than 1200 charge/discharge cycles at 80% Depth of discharge (DOD) at an average temperature of 27º Celsius. DOD (Depth of Discharge) is defined as the ratio of the quantity of electricity (in Ampere-hour) removed from a cell or battery on discharge to its rated capacity. The battery sets shall have a minimum expected operational life of 5 years at normal operating conditions or 1200 charge/discharge cycles (whichever is early).

### 4.7 Routine Maintenance of Battery system

For routine maintenance of battery system, the contractor shall supply one set for each Constituent of following tools:

a. Torque wrench.
b. Tool for opening /closing of pressure regulation valve of battery.

### 4.8 Testing requirements

The Contractor shall submit type test reports for the battery for the same make, model & rating as offered as per the IEC 60896 or equivalent IS/EN/BS/TEC standards. In the event, the type test reports for exact rating is not available, the Contractor shall submit type test reports for higher rating Battery.

**----------End of this Section----------**

# Section - 5

# Environment, EMI, Power Supply, Cabling and Earthing

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# Section - 5

# Environment, EMI, Power Supply, Cabling and Earthing

The purpose of this section is to describe the minimum general equipment characteristics and specifications for environmental conditions, source power conditioning and backup, equipment construction, and installation. The section also highlights the stringent Electro Magnetic Compatibility (EMC) guidelines for equipment that will be operated under the severest Electro Magnetic Interference (EMI) and Electro Static Discharge (ESD) conditions expected in an Extra High Voltage (EHV) power system environment.

## 5.1 Environmental Requirements

Equipment and their components provided under this specification shall operate reliably under the following environmental conditions.

### 5.1.1 Temperature and Humidity

Most of the equipment will not be installed in environmentally controlled shelters. Therefore, equipment shall operate in accordance with the limits shown in Table 5-1.

**Table 5-1**
**Environmental Operating Limits**

| | |
|---|---|
| **Temperature Range:**<br><br>**Specification**<br>**Operation without damage**<br>**Shipping/storage** | (Un Controlled Environment)<br><br>0 to 45°C<br>-10 to 55°C<br>-40 to 60°C |
| **Relative Humidity, non-condensing** | Upto 90% |
| **Elevation:**<br>**Operating**<br>**Non-operating** | <br>to 3,000 m<br>to 10,000 m |

For each location, the Contractor is required to assess the environmental conditions for the equipment to be installed under this specification. The Contractor is responsible for all necessary enclosure, rack or equipment upgrades to ensure the proper operation of the installed equipment.

### 5.1.2 EMI and Electrostatic Interference

At each location, the Contractor shall assess the need for shielding against radiated emissions and shall provide recommended solutions for any EMI problem found at each location. Specifications provides the type of immunity tests for which the equipment shall be required to pass without failure. For the individual tests to be carried out at the different interfaces,

references are made to the relevant IEC and ITU-T recommendations.

### 5.1.3 Vibration and Shock Resistance

As per testing requirements indicated in this specification.

### 5.1.4 Tropicalization

Communications equipment will often be stored and operated in uncontrolled environment areas and will be subject to mould, growth of fungus, corrosion and oxidation. The equipment and components shall be suitably tropicalized during manufacture through commissioning, as necessary.

### 5.1.5 Contaminants

Communications equipment may be located in areas of poor air quality with the main contaminant being dust. Cabinets shall be tight fitting utilizing filtered ventilation openings only.

## 5.2 Primary Source AC/DC Power Requirements

Facilities will be required to support both AC and DC power load requirements of telecommunications equipment as specified below:

### 5.2.1 Primary Source AC Power

It will be the Employer's responsibility to provide required Primary AC source Power for communications equipment installed under this specification. The Primary AC Power supplied will be 240 VAC ± 10%, 50Hz with a frequency variance between 46 and 55 Hz. Harmonic distortion will not exceed five (5) percent.

All equipment and components provided under this specification requiring Primary AC Power, shall be designed for normal operation under the above stated tolerances for 240 VAC supply.

The Contractor shall provide in their Bid as well as in the survey report to the Employer the projected 240 VAC Primary Power load requirement per equipment and totals, by location, for equipment provided under this specification. The Contractor shall provide suitable UPS for communication equipment/module etc. requiring AC power supply at locations other than control centre.

### 5.2.2 -48V DC Power

Power supplies/converters for communications equipment (except computer system supplied as part of NMS which shall use 240 VAC) provided under this specification, shall use -48Vdc uninterrupted primary source power. The power supply may vary normally within the voltage range -42 to -58 Vdc and the supplied equipment shall operate satisfactorily within this range. The power supply exists at wideband locations where Fibre Optic Communication links are to be implemented inlieu of existing digital microwave system. However, at new wideband nodes, the

contractor shall be responsible for providing the power supply to the communication equipment.

### 5.2.3 Power Distribution and Protection

The Employer will furnish only one source primary 240 VAC and/or -48 VDC power. It shall be the Contractor's responsibility for the connection and distribution of all Primary AC and -48V dc source power, in full compliance with all local and national electrical codes.

The Employer shall indicate during the survey by Contractor, on the primary source, the feeders/points that can be used by the Contractor. The Contractor shall supply & install Primary AC and -48Vdc feeder cables to Contractor-furnished distribution panels.

The Contractor shall provide required distribution panels, circuit breakers and appropriate Panel Disconnects. Distribution Panel feeders, Panel Disconnects, distribution panels and circuit breakers shall be sized and equipped to support at least 100% expanded load requirements.

The Contractor shall provide and install all required primary power distribution sourced from the distribution panels. The Contractor shall also be responsible for Load Balancing.

The Contractor is responsible for all inter-rack (enclosure) and intra-rack (enclosure) power distribution required to support equipment supplied under this specification. The Contractor shall provide all cabling, fusing, switching and circuit breaker and surge protection required.

Partially equipped subsystems shall be installed with provision for expansion. Equipment power supplies provided under this specification, shall be sized to support fully equipped subsystems. Primary power distribution protection shall be sized to support and protect maximum operating load potential whether or not the actual projected load shall meet that maximum load potential.

The Contractor shall provide equipment and rack safety earthing in compliance with this specification.

## 5.3 Equipment Construction, Assembly and Installation

All equipment supplied under this specification shall be constructed, assembled and installed in accordance with the following requirements:

### 5.3.1 Identification

All cabling, racks/enclosures, equipment, modules and materials shall be uniquely identifiable as per the following:

#### 5.3.1.1 Equipment

Each equipment component to the level of printed circuit card, shall be clearly marked with the manufacturer's part number, serial number, month/year of manufacture and revision level. Changes to components shall be identified by an unambiguous change to the marked revision level. The Contractor shall be responsible for maintaining the master revision level list until the

Contractor has complied with all requirements of this specification.

Where custom components and parts are provided, each component/part shall be marked to specifically identify that component/part. Printed circuit card cages are defined as an equipment component and as such, shall be clearly identified as stated within this specification.

Equipment chassis and printed circuit card cages having wired backplanes, shall be clearly marked with the manufacturer's part number, serial number, month/year of manufacture, revision level and an additional identifier corresponding directly to the applicable backplane wiring diagram/list.

#### 5.3.1.2 Power Distribution

Power distribution panels shall be clearly marked with their unique identifier, source feed information, and remote source feed emergency disconnect location and identity.

Power distribution panel "Main Disconnect" and circuit breakers shall be clearly marked with a unique identifier. Circuit breaker feed lists shall be clear, accurate and the feed list information shall be posted inside each distribution panel door.

Inter-rack and intra-rack (enclosure) power distribution shall be clearly identified with source feed, voltage and power rating information. All power feed cabling shall be clearly identified near the point of termination.

All power distribution identification shall utilize heat-resistant permanent marking techniques such as stamped non-metallic tags, embossed labels, etc. Marking techniques are subject to approval by the the Employer. Power distribution identifiers and information shall agree with the Contractor's power cable plant drawings.

#### 5.3.1.3 Signal Cabling

Connectorised signal cabling/wiring requires marking with a unique identifier at each connectorised end. The signal cable/wire identifier shall include a cable identifier and the location of both terminations.

Signal cable/wiring installed on terminal blocks requires marking with the cable identifier and distant end location. The cable tag shall be clearly visible at the cable fanout point.

All signal cable, wiring and terminations shall be clearly labelled/tagged with identifiers consistent with Contractor supplied cable plant records. Marking techniques are subject to approval by the Employer.

#### 5.3.1.4 Equipment Racks and Enclosures

All equipment racks, enclosures and equipment, including distribution frames, shall be clearly labelled with unique identifiers consistent with Contractor supplied floor plans and rack elevations.

### 5.3.2 Installation Hardware

Equipment racks, enclosures, cable raceways and installation hardware shall, at a minimum, comply with the following requirements:

#### 5.3.2.1 Equipment Sub-Racks and Cabinets (Enclosures)

All equipment provided under this specification, shall be physically mounted in sub-racks and cabinets (enclosures). The Contractor shall determine and propose for the Employer approval, the type, size, weight and manner of installation for each location.

Selection of equipment sub-racks and cabinets (enclosures) shall meet the following requirements:

**(A) Equipment SubRack Construction**

Equipment Sub Racks provided for installation in environmentally controlled facilities, shall meet the following minimum requirements:

(1) Equipment Sub Racks shall be steel/aluminium fabricated and finished on all surfaces. All metal and welds shall be thoroughly cleaned and sanded to obtain a smooth finish. All surfaces shall be treated for rust and primed to form a bond between metal and the finish coats of paint.

(2) Equipment covers shall be provided for exposed components mounted in equipment sub Racks.

(3) Dust and moisture protection shall meet or exceed IP20 standards.

**(B) Equipment Cabinet (Enclosure) Construction**

(1) Equipment cabinets (enclosures) shall be steel/ steel & Aluminium extrusion fabricated and finished on all surfaces. All metal and welds shall be thoroughly cleaned and sanded to obtain a smooth finish. All surfaces shall be treated for rust and primed to form a bond between metal and the finish coats of paint.

(2) Equipment cabinets (enclosures) shall be designed free-standing but shall be mounted to the floor. Cabinets (enclosures) shall have secure fitting, lockable , full-length front doors for access to hardware and wiring. Equipment covers for exposed components mounted inside cabinets are not required unless specifically recommended.

(3) All doors and removable panels shall be fitted with long life rubber beading. All panels shall be fabricated from minimum 2.0mm thickness steel sheet. However, for racks with load bearing Aluminium extrusion frame, door panels and side panels may be fabricated from minimum 1.6mm thickness steel sheet and the top

& bottom panels shall be fabricated from minimum 2.0mm thickness steel sheet.

(4) Equipment cabinets (enclosures) shall be dust and moisture-proof as per IP41 specification, or better.

#### 5.3.2.2 Cable Raceways

The Contractor is required to provide and install all additional necessary indoor and outdoor cable raceways. The cable raceways shall be in conformance with the following:

(1) Signal cabling and power cabling shall require separate cable raceways. Signal and power cabling shall not share the same raceways and shall be installed as far apart as is practical. Adequate shielding shall be provided as required.

(2) All cable raceways shall be sized to support full loading requirements plus at least a 200% safety loading factor.

(3) Outdoor cable raceways shall be of corrugated construction and shall be fitted with solid covers overlapping all sides of the cable raceways.

(4) Outdoor cable raceways shall be fabricated from construction grade aluminum, galvanized iron or anodized sheet metal or any other suitable material approved by the Employer. Suitable anti-corrosion measures shall be taken. Steel fabricated raceways shall be finished inside and out, treated to resist rust and to form a metal-to-paint bond.

(5) Indoor cable raceways fabricated of aluminum or galvanized iron, shall not normally need special finishing or painting, unless otherwise stipulated by the Employer. Steel fabricated raceways shall require a red oxide primer coat at a minimum.

### 5.3.3 Signalling Distribution

The Contractor shall be responsible for all signal wiring associated with furnished equipment in accordance with the following:

(1) All signal wiring connections to the communications equipment shall be via Krone type or equivalent terminal blocks.

(2) The Contractor shall provide subscriber level wiring and patching wherever required.

### 5.3.4 Lightning and Transient Voltage Protection

The Contractor shall be required to provide protection from lightning and transient voltages for all wideband communications equipment, in accordance with the following:

(1) At the outside cable plant point-of-entry of all cabling penetrations for all cabling installed by the Contractor, the Contractor shall provide lightning and transient voltage isolation for the inside plants cabling, wiring, and all terminations and equipment.

(2) All equipment installed under this specification that requires 240VAC primary power, shall be surge protected.

### 5.3.5 Station Safety Earthing and Signal Grounding

For each facility, the Contractor is responsible for meeting the following station and equipment earthing requirements:

(1) All safety earthing and signal grounding shall be in full compliance with EMI/EMC requirements as per relevant international standards

(2) Each cabinet (enclosure) or cabinet (enclosure) group shall include suitable signal ground and safety earth networks. The signal ground network shall terminate at a separate signal ground stud connection isolated from safety earth.

(3) Each earth/ground network shall utilize copper bus bars, copper braids and/or 16 sqmm or bigger earth cable. All equipment earth/ground connections shall be made directly to the equipment chassis utilizing grounding lugs and secured metal-to-metal with star washers. Use of the enclosure frame, skin or chassis mounting hardware as part of the earthing/grounding networks, is not acceptable.

(4) The safety earth network shall be connected to "earth ground" at the safety earth stud. The earth stud connection shall be sized for an external earthing cable equipped with a 2/0 solid copper lug secured metal-to-metal with star washers. Primary AC feeds and distribution within enclosures requires earthing wire connection to the safety earth stud.

(5) The safety earth and signal ground networks shall be inter-connected only at the safety earth stud and signal ground stud.

The Contractor shall extend the existing station earth to the equipment room using suitable G.I. earthing strip (50 x 6 mm), wherever required. .

The Contractor is responsible for providing all required earthing/grounding cable and installation. Cabinet (Enclosure) and equipment safety earthing and signal grounding shall be subject to the Employer's approval.

The Contractor shall be responsible for determining the suitability of existing station earth for the equipment to be supplied under this contract. In case existing earthing arrangement at the site is not adequate, the Contractor shall either make improvement in the existing earthing arrangement or make new earthing as per requirement.

### 5.3.6 Interconnections

All power and signal cabling between component units of the communications systems shall be supplied and installed by the Contractor and shall be shown on contractor-supplied as-built drawings.

The Contractor shall supply and install all primary power cords, powerstrips, receptacles, circuit breakers, fuse panels, switches, earth fault detectors, surge protectors, distribution cabling, and power connectors required to support all equipment enclosures and system components furnished and installed under this specification, except as specifically excluded.

Plug-type power connectors with captive fastening (such as "Twist-Lock") shall be used for interconnection of source power to the equipment enclosures or racks.

Plug-type connectors with captive fasteners (ie. DB-25, etc) shall be used for the interconnection of all inter and intra-enclosure signalling cable.

### 5.3.7 Finish Colors

Unless otherwise specified, finish colors for enclosures shall be gloss white enamel on the inside, and semi-gloss medium grey enamel on the outside. Only brushed aluminum trim shall be used. Employer reserves the right to approve the proposed color scheme.

## 5.4 Location of Equipment, Cable Routes and Associated Civil Works

During the Site Surveys, the Contractor shall determine and propose locations for all equipment to be supplied under this contract. Further, the Contractor shall locate and identify proposed routing for all cabling between all equipment locations including existing and planned equipment not provided under this contract, but required to be connected under the scope of this contract. This subsection defines the requirements and clarifies the responsibilities of the Employer and the Contractor regarding equipment siting, intra and inter facility interconnectivity and necessary associated civil works.

### 5.4.1 Locations for Supplied Equipment

All transmission equipment, the NMS and associated DDFs and MDFs, shall generally be colocated in the same communications room located in the Control Building whenever possible.

### 5.4.2 Associated Civil Works

The Contractor shall provide all required minor civil works necessary for full connectivity as required in the Contractor's scope of work as follows:

(1) All wall and floor penetrations necessary for the installation of all cabling to be performed in accordance with the requirements of this specification.

(2) Installation of racks, cabinets, cable raceways, and cabling supplied as part of this contract.

### 5.4.3 Cable Trenches

A network of cable trenches and/or ducts may exist at some sites but shall require expansion and/or new construction at some stations. It shall be a responsibility of the contractor to cooperate fully with the Employer and all other on-going project contractors in the planning and efficient use of existing and new cable trenches. The existing cable trenches/ cable raceways proposed to be used shall be identified in the survey report. The contractor shall make its best effort to route the cable through the existing available cable trenches. Where suitable existing cable trenches are not available, suitable alternatives shall be proposed for Employer approval. The Employer shall provide any additional cable trenches required for such approved alternatives.

It may be noted that in order to utilise the existing trenches, the Contractor supplied cables may be required to be co-located with LV cables. Accordingly, the contractor shall ensure that selection and installation of cables is suitable for the purpose. The contractor shall be responsible for new building penetrations required for supplied cabling. Caution shall be taken to ensure existing equipment and site personnel are protected from dust and debris incident to the cable penetration work. Penetration shall be neatly formed and sealed for protection from moisture, dust wind and vermin intrusion.
All required fitting, supports, accessories, ducts, inner ducts, conduits, riser and any item not specially mentioned but required for lay and installation of cables in trenches shall be supplied and installed by the Contractor.

**----------End of this Section----------**

# Section - 06

# Inspection, Test and Availability

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## Section - 06

## Inspection, Test and Availability

All materials furnished and all work performed under this Contract shall be inspected and tested. Deliverables shall not be shipped until all required inspections and tests have been completed, and all deficiencies have been corrected to comply with this Specification and approved for shipment by the Employer.

Except where otherwise specified, the Contractor shall provide all manpower and materials for tests, including testing facilities, logistics, power and instrumentation, and replacement of damaged parts. The costs shall be borne by the Contractor and shall be deemed to be included in the contract price.

The entire cost of testing for factory & site acceptance, routine tests, production tests and other test during manufacture & site activities specified herein shall be treated as included in the quoted unit price of materials, except for the expenses of Inspector/Employer's representative.

Acceptance or waiver of tests shall not relieve the Contractor from the responsibility to furnish material in accordance with the specifications.

All tests shall be witnessed by the Employer and/or its authorized representative (hereinafter referred to as the Employer) unless the Employer authorizes testing to proceed without witness. The Employer representative shall sign the test form indicating approval of successful tests.

Should any inspections or tests indicate that specific item does not meet Specification requirements, the appropriate items shall be replaced, upgraded, or added by the Contractor as necessary to correct the noted deficiencies at no cost to the Employer. After correction of a deficiency, all necessary retests shall be performed to verify the effectiveness of the corrective action.

The Employer reserves the right to require the Contractor to perform, at the Employer's expense, any other reasonable test(s) at the Contractor's premises, on site, or elsewhere in addition to the specified Type, Acceptance, Routine, or Manufacturing tests to assure the Employer of specification compliance.

All security related features shall be demonstrated during FAT/SAT as required by the Employer.

## 6.1 Inspection

Access to the Contractor's facilities during system manufacturing and testing and to any facility where systems/ equipment are being produced/ tested/ integrated for the fibre optic communication network, shall be available to the Employer. At all times the Employer shall have full facilities for unrestricted inspection of such materials or equipment. To facilitate this, the Contractor shall submit for the Employer approval, a comprehensive Quality Assurance Plan using ISO 9000 as a general guideline. In addition, the Quality Assurance Plan shall satisfy the following:

(a) Sufficient office facilities, equipment, and documentation necessary to complete all inspections and to verify that the equipment is being fabricated and maintained in accordance with the Specification shall be provided by the Contractor to the Employer.

(b) Inspections to be performed by the Employer will include visual examination of hardware, cable dressings, and labelling. Contractor's documentation will also be examined to verify that it adequately identifies and describes all offered items and spare parts.

(c) Access to inspect the Contractor's standards, procedures, and records that are applicable to the supplied equipment shall be provided to the Employer. Documents will be inspected to verify that the Contractor has performed the required quality assurance activities.

(d) The inspection rights described above shall also apply to sub Contractors who are responsible for supplying major components described in this Specification. These items shall be inspected and tested at the sub Contractor's factory by the Employer's representatives prior to shipping this equipment to the Contractor's facility or directly to the Employer.

(e) The above inspection rights shall also apply to sub Contractors supplying assemblies, subassemblies and components. However, such items will normally be inspected and tested by the Employer's representatives at the Contractor's site before acceptance.

## 6.2 Test Plans and Procedures

Test plans and test procedures for both factory and site acceptance tests shall be provided by the Contractor. Test plans and test procedures shall ensure that each factory and site test is comprehensive and verify all the features of the equipment to be tested. Test plans and test procedures shall be modular to allow individual test segments to be repeated upon request.

The Contractor shall submit a Test Schedule for the Employer's approval within one (1) week after the award of contract for Type Tests and three (3) months after the award of contract for all other tests. The test schedule shall list the tests to be carried out, and the approximate test

duration. The test periods shall also be indicated in the PERT chart or equivalent for the work.

The Contractor shall give the Employer twenty one (21) days written notice of any material being ready for testing. Fifteen days prior to the scheduled testing, the Employer shall provide written notice to the Contractor of any drawings, equipment, material, or workmanship which, in the Employer's opinion, are not compliant to the specification. The Contractor shall give due consideration to such objections, if valid, effecting the corrections as necessary or shall prove, in writing, that said modifications are unnecessary for contract compliance.

### 6.2.1 Factory and Site Test Plans

A test plan for factory and site acceptance tests shall be submitted for approval, at least four (4) weeks before the start of testing. The test plan shall be a single overview document that defines the overall schedule and individual responsibilities associated with conducting the tests, documenting the test results, and successfully completing the test criteria. Test Plans shall include, at a minimum, the information contained in Table 6-1.

**Table 6-1**
**Factory & field Test Plan Requirements**

| Item: | Description: |
|---|---|
| **1.** | Test schedule |
| **2.** | Record-keeping assignments, procedures and forms |
| **3.** | Procedures for monitoring, correcting and retesting variances |
| **4.** | Procedures for controlling and documenting all changes made to the communications equipment after the start of testing |

### 6.2.2 Test Procedures

Test procedures for factory and site testing shall be submitted for the Employer approval at least four (4) weeks before each individual test. Fully approved test procedures shall be submitted to the Employer at least four weeks prior to the commencement of testing. Testing shall not commence without approved test procedures. At a minimum, test procedures shall include the items listed in Table 6-2.

All test equipment and/or instruments shall bear calibration stickers indicating valid calibration on and beyond the testing date. The time lapsed since last calibration shall not exceed the test equipment/ jig manufacturer recommended calibration interval or the interval recommended in the test lab's internal quality procedures.

The Contractor shall ensure that all testing will be performed by qualified testing personnel well experienced in performing such tests.

**Table 6-2**

**Test Procedure Requirements**

| Item: | Description: |
|---|---|
| **1.** | Test Title and Revision Level, if applicable |
| **2.** | List of Standard(s) complied with |
| **3.** | Function(s) / parameter(s) to be tested |
| **4.** | Purpose of each test segment |
| **5.** | List of required test equipment |
| **6.** | Description of any special test conditions or special actions required. This includes complete descriptions, listings and user interface procedures for all special hardware and software tools and/or display formats to be used during the test. |
| **7.** | Test setup including test configuration block diagrams and/or illustrations. |
| **8.** | Test procedures to be followed. |
| **9.** | Required inputs and expected outputs for each test segment |
| **10.** | Acceptance criteria for each test segment. |
| **11.** | List of test data to be supplied by the Contractor(s) and copies of any certified data to be used |
| **12**. | Format of test reports. |

### 6.2.3 Test Records

Complete and indexed records of all factory and site acceptance tests results shall be maintained and provided to the Employer by the Contractor in hardcopy. The records shall be keyed to the steps enumerated in the test procedures. The minimal items required in test records are described in Table 6-3.

**Table 6-3**

**Test Record Requirements**

| Item: | Description: |
|---|---|
| **1.** | Test Title and Revision Level, if applicable; contract references |
| **2.** | Date and time for test start and test completed |
| **3.** | Test title and reference to the appropriate section of the test procedures |
| **4.** | Description of any special test conditions or special actions taken (Includes test-case data). |
| **5.** | Test results for each test segment including an indication of Passed, Conditional Pass, Incomplete or Failed. |
| **6.** | Test procedure modifications made during testing. |
| **7.** | Variance Report(s) tracking information and copies (if variance(s) was detected). |
| **8.** | Contractor's test engineer(s) identification, signature and remarks |

**Table 6-3**

**Test Record Requirements**

| Item: | Description: |
|---|---|
| **9.** | Employer's test witness identification, signature and remarks |
| **10.** | List of all attachments |
| **11.** | Attachments (including system logs, printouts, variances, hard copies of visual test result displays, etc.) |

All principle test records, test certificates and performance curves shall be supplied for all tests carried out as proof of compliance with the specifications and/or each and every specified test. These test certificates, records and performance curves shall be supplied for all tests, whether or not they have been witnessed by the Employer within the specified duration after the completion of test. Information given on such test certificates and curves shall be sufficient to identify the material or equipment to which the certificates refer, and shall also bear the Contractor's reference and heading.

### 6.2.4 Rejection of Elements

Any item or component which fails to comply with the requirements of this Specification in any respect, at any stage of manufacture, test, erection or on completion at site may be rejected by the Employer either in whole or part as considered necessary.

Material or components with defects of such a nature that do not meet the requirements of the Specification by adjustment or modification shall be replaced by the Contractor at his own expense. After adjustment or modification, the Contractor shall submit the items to the Employer for further inspection and/or tests.

### 6.2.5 Test Periods Defined

The terminology used in Volume I, General Conditions of Contract and their correlation with the tests requirements described within this section is as follows:

Pre-Commissioning & Commissioning Period - The Site Acceptance Test (SAT)
Operational Acceptance - Successful completion of SAT

## 6.3 Type Testing

"Type Tests" shall be defined as those tests which are to be carried out to prove the design, process of manufacture and general conformity of the materials to this Specification. Type Testing shall comply with the following:

(a) All equipment being supplied shall conform to type tests as per technical specification.

(b) The test reports submitted shall be of the tests conducted within last seven (7) years for OPGW cable and five (5) years for Telecom equipment prior to the date of bid opening. In case the test reports are older than seven (7) years for OPGW cable and last five (5) years for Telecom equipment on the date of bid opening, the Contractor shall repeat these tests at no extra cost to the purchaser.

(c) The Contractor shall submit, within 30 days of Contract Award, copies of test reports for all of the Type Tests that are specified in the specifications and that have previously ( before Contract award) been performed. These reports may be accepted by the Employer only if they apply to materials and equipment that are essentially identical to those due to be delivered under the Contract and only if test procedures and parameter values are identical to those specified in this specifications carried out at accredited labs and witnessed by third party / customer's representatives.

In the event of any discrepancy in the test reports or any type tests not carried out, same shall be carried out by Contractor without any additional cost implication to the Employer.

(d) Type Tests shall be certified or performed by reputed laboratories using material and equipment data sheets and test procedures that have been approved by the Employer. The test procedures shall be formatted as defined in the technical specifications and shall include a complete list of the applicable reference standards and submitted for Employer approval at least four (4) weeks before commencement of test(s). The Contractor shall provide the Employer at least 30 days written notice of the planned commencement of each type test.

(e) The Contractor shall provide a detailed schedule for performing all specified type tests. These tests shall be performed in the presence of a representative of the Employer.

(f) The Contractor shall ensure that all type tests can be completed within the time schedule offered in his Technical Proposal.

()

(g) In case of failure during any type test, the Supplier is either required to manufacture a fresh sample lot and repeat all type tests successfully or repeat that particular type test(s) at least three times successfully on the samples selected from the already manufactured lot at his own expenses. In case a fresh lot is manufactured for testing then the lot already manufactured shall be rejected.

### 6.3.1 Type Test Samples

The Contractor shall supply equipment/material for sample selection only after the Quality Assurance Plan has been approved by the Employer. The sample material shall be manufactured strictly in accordance with the approved Quality Assurance Plan. The Contractor shall submit for Employer approval, the type test sample selection procedure. The

selection process for conducting the type tests shall ensure that samples are selected at random. At least three samples of each of the proposed equipment shall be offered for selection, out of which one sample for each equipment shall be selected.

### 6.3.2 List of Type Tests

The type testing shall be conducted on the following equipment

(a) SDH Equipment with all types of cards (optical card, Tributary card or any other equipment as part of repeater less links)
(b) Primary Multiplexer & Drop – Insert Mux with subscriber interface card
(c) DACS
(d) DCPC & Battery
(e) Optical fibres
(f) OPGW Cable
(g) OPGW Cable fittings
(h) Vibration Damper
(i) Splice Enclosure (Joint Box)
(j) Approach Cable

### 6.3.2.1 List of type test to be conducted on Telecom equipment

(SDH Equipment with all types of cards, Primary Multiplexer & Drop – Insert Mux with subscriber interface card and DACS)

#### 6.3.2.1.1 Temperature and Humidity Tests

The tests listed below are defined in IEC Publication 60068.

**(a) Low Temperature Test: Operation to Specifications**

Low temperature tests shall be conducted as defined in IEC Publication 60068-2-1, test method Ad, with the following specifications:

(1) Test Duration: The equipment is started up as soon as thermal equilibrium has been reached and operated for sixteen (16) hours. Its performance is checked during the test.

(2) Degree of Severity: Test shall be done at 0°C

(3) Acceptance Criteria: No degradation of performance during and after the test.

**(b) Low Temperature Test : Operation without Damage**

Low temperature tests shall be conducted as defined in IEC Publication 60068-2-1, test method Ad, with the following specifications:

(1) Test Duration: The equipment is started up as soon as thermal equilibrium has been reached and operated for 72 hours. Its performance is checked during the test and after the test as soon as the thermal equilibrium is reached at the room temperature (*Post-test*).

(2) Degree of Severity: Test shall be done at -10° C

(3) Acceptance Criteria: Degradation of performance is allowable during the test, however there shall be no degradation of performance in the *post-test*.

**(c) Dry Heat Test: Operation to Specifications**

Dry heat test shall be done as defined in IEC Publication 60068-2-2, test method Bd, with the following specifications:

(1) Test Duration: The equipment is started up as soon as thermal equilibrium

has been reached and operated for 96 hours. Its performance is checked during the test.

(2) Degree of Severity: As per table 5-1: operation to specification range.

(3) Acceptance Criteria: No degradation of performance during and after the test.

**(d) Dry Heat Test: Operation without Damage**

Dry heat tests shall be done as defined in IEC Publication 60068-2-2, test method Bd, with the following specifications:

(1) Test Duration: The equipment is started up as soon as thermal equilibrium has been reached and operated for 96 hours. Its performance is checked during the test and after the test as soon as the thermal equilibrium is reached at the room temperature (*Post-test*).

(2) Degree of Severity: Test shall be done at 55ºC.

(3) Acceptance Criteria: Degradation of performance is allowable during the test, however there shall be no degradation of performance in the *post-test*.

**(e) Damp Heat Test**

Damp heat testing reveals aging with respect to the humidity level and applies basically to electronic equipment. This test shall be done as defined in IEC Publication 60068-2-3 with the following specifications:

(1) Test Duration: The equipment is started up as soon as thermal equilibrium has been reached and operated for 10 days. Its performance is checked during the test.

(2) Acceptance Criteria: The equipment shall meet the specified requirement and there shall not be any degradation in BER.

**(f) Temperature Variation Test**

Temperature variation testing shall be as per IEC Publication 60068-2-14 (Gradual Variations, Method Nb). The equipment shall be powered on and various parameters shall be monitored continuously during the test period.

(1) Number of cycles required is five (5)

(2) The degree of severity: temperature TL:0°C, TH: As per table 5-1 (Operation to specification range)

(3) Cycle duration for each temperature is three (3) hours.

(4) Ramp : 1 $^{o}$C/minute.

(5) Acceptance Criteria: The equipment shall meet the specified requirement and there shall not be any degradation in BER.

#### 6.3.2.1.2 Power Supply and EMI/EMC tests

The test procedure and acceptance criteria shall be as defined in IEC 60870-2-1.

**(a) Immunity Tests**

The list of Immunity tests are specified below in Table 6-4:

**Table 6-4: Recommended Immunity Tests**

| S. No. | Immunity Test IEC 1000-4-1 | AC Power Supply | DC Power Supply | Control & Signal | Telecom Line | Para-metres |
|---|---|---|---|---|---|---|
| **1** | Voltage Fluctuations | Yes | Yes | N/A | N/A | Table 11 of IEC 60870-2-1: 1995 - **Level : 1** |
| **2** | Voltage dips and Interruptions | Yes | Yes | N/A | N/A | |
| **3** | 100/1300 µs surge | Yes | Yes | N/A | N/A | Table 12 of IEC 60870-2-1: 1995 |
| **4** | 1.2/50 - 8/20 µs surges | Yes | Yes | Yes | N/A | Table 12 of IEC 60870-2-1: 1995 - **Level : 4** |
| **5** | Fast transient bursts | Yes | Yes | Yes | Yes | |
| **6** | Damped oscillatory waves | Yes | Yes | Yes | Yes | |
| **7** | 10/700 µs surges | N/A | N/A | N/A | Yes | |
| **8** | Electrostatic discharge | Yes | | | | Table 13 of IEC 60870-2-1: 1995 - **Level : 4** |
| **9** | Power frequency magnetic field | Yes | | | | Table 14 of IEC 60870-2-1: 1995 - **Level : 4** |
| **10** | Damped oscillatory magnetic field | Yes | | | | |
| **11** | Radiated electromagnetic field | Yes | | | | Table 15 of IEC 60870-2-1: 1995 - **Level : 4** |

**Table 6-4: Recommended Immunity Tests**

| S. No. | Immunity Test IEC 1000-4-1 | AC Power Supply | DC Power Supply | Control & Signal | Telecom Line | Para-metres |
|---|---|---|---|---|---|---|
| **12** | Power Frequency voltage on control and signal lines | N/A | N/A | Yes | Yes | IEC 61000-4-16 : 2002-07 **Level : 4** |
| **13** | DC voltage on control and signal lines | N/A | N/A | Yes | N/A | IEC 61000-4-16 : 2002-07 **Level : 4** |
| **-End of Table-** | | | | | | |

**(b) Emission Tests**

The list of Emission tests are specified below in Table 6-5

**Table 6-5:**
**Recommended Emission Tests**

| S. NO. | Emission test | AC Power Supply | DC Power Supply | Control & Signal | Telecom Line | Para-metres |
|---|---|---|---|---|---|---|
| **1** | LF disturbance voltages CCITT recommendation P.53 | N/A | Yes | N/A | N/A | Table 17 of IEC 60870-2-1: 1995 - Class **: B** |
| **2** | Transient disturbance voltages | Yes | Yes | N/A | N/A | |
| **3** | RF disturbance voltages CISPR 22 | Yes | Yes | N/A | N/A | |
| **4** | RF disturbance currents CISPR 22 | N/A | N/A | N/A | Yes | |
| **5** | RF radiated fields CISPR 22 | Yes | | | | |
| **-End Of Table-** | | | | | | |

**(c) Insulation Withstand Voltages**

As per section 6 of IEC 60870-2-1. Recommended class : VW1 of Table 18.

**6.3.2.1.3 Mechanical Tests**

**(a) Mechanical Vibration Test**

The procedure for this test is described in IEC Publication 60068-2-6. The testing procedure shall be carried out in the sequence 8.1 + 8.2.1 + 8.1 as described in document 60068-2-6.

For the vibration response investigation (clause 8.1 of 60068-2-6), the test shall be carried out over a sweep cycle under the same conditions as for the endurance test (described later), but the vibration amplitude and the sweep rate may be decreased below these conditions so that the determination of the response characteristics can be obtained.

The endurance test conditions are selected according to the vibration withstand requirements.

Transportation tests shall be performed with the equipment packed according to the Contractor's specifications.

**(b) Shock Test**

The procedure of this test is defined in IEC Publication 60068-2-27 (each test) with a semisinusoidal shape (clause 3.1.1.2).

The recommended severity shall be A = 294 $m/s^2$, D = 18 ms. Three shocks per axis per direction shall be applied to the equipment packed according to the Contractor's specifications.

**Or Free Fall Test**

This test could be performed as an alternative to the shock or Bump test. The procedure is defined in IEC publication 60068-2-32. The equipment shall be packed according to the Contractor's specifications. The drop height shall be defined in accordance with IEC 60068-2-32 . The surface of the packing case which comes into contact with the ground is the surface on which the packing case normally rests; if the packing does not have any features (inscription, special shape, etc.) identifying this surface, the test is carried out successively on all the surfaces of the packing.

**Or Bump Test**

This test could be performed as an alternative to Shock test or Free Fall test. The procedure is defined in IEC 60068-2-29.

### 6.3.2.2 Type Testing of DCPS

The test reports for Immunity, Emission and safety must be in accordance with relevant IEC/CISPR standards shall be submitted. The Contractor shall submit the DCPS type test reports of earlier conducted tests on the same make, model, type & rating which shall include the following tests listed in Table 6-6.

**Table 6-6**
**Type Tests on DCPS**

| | |
|---|---|
| 1 | Surge immunity (Level 4- as per IEC 61000-4-5) |
| 2 | Electrical Fast Transients/Burst (Level 4 – as per IEC 61000-4-4) |
| 3 | Electrostatic Discharge (Level 4 – as per IEC 61000-4-2) |
| 4 | Radiated Electromagnetic Field (Level 3 – as per IEC 61000-4-3) |
| 5 | Conducted disturbances induced by radio-frequency field (Level 3 – as per IEC 61000-4-6) |
| 6 | Damped oscillatory magnetic field (Level 3 – as per IEC 61000-4-10) |
| 7 | Voltage dips, short interruptions and voltage variations (Level 2 – as per IEC 61000-4-11) |
| 8 | Conducted Emission (Level - Class A, Group 1 as per IEC CISPR 11) |
| 9 | Radiated Emission (Level - Class A, Group 1 as per IEC CISPR 11) |
| 10 | Safety Tests (as per IEC 60950) |

### 6.3.2.3 Testing requirements of Battery

**Table 6-7**
**List of tests for VRLA battery**

| Sl. No. | Test | Type Test As per IEC 60896 | FAT | SAT |
|---|---|---|---|---|
| 1. | Verification of marking<br>- Visual observation<br>- Dimensional inspection<br>- Polarity checking | √ | √ | √ |
| 2. | Capacity test | √ | √ | √ |
| 3. | Suitability for floating battery operation (to be conducted for 3 months instead of six months) | √ | | |
| 4. | Endurance in discharge/charge cycles (instead of 50, 25 discharge / charge cycles shall be followed) | √ | | |
| 5. | Charge Retention | √ | | |

| Sl. No. | Test | Type Test As per IEC 60896 | FAT | SAT |
|---|---|---|---|---|
| | | | | |
| 6. | Short-circuit current and internal resistance | √ | | |
| 7. | Mechanical Tests<br>-Vibration Test<br>(procedure as per IEC 60068-2-6)<br>- Free fall Test<br>(procedure as per IEC 60068-2-32) | √ | | |
| **NOTE :**<br>The batteries shall meet the general requirements as per IEC 60896 or equivalent. | | | | |

### 6.3.2.4 Type Tests for Optical Fibres

The type tests listed below in table 6-8 shall be conducted on DWSM fibres to be supplied as part of overhead cables. The tests specific to the cable type are listed in subsequent sections.

**Table 6-8**
**Type Tests For Optical Fibres**

| S. No. | Test Name | Acceptance Criteria | Test procedure |
|---|---|---|---|
| **1** | Attenuation | As per Section-02 of TS | IEC 60793-1-40<br>Or EIA/TIA 455-78A |
| **2** | Attenuation Variation with Wavelength | As per Section-02 of TS | IEC 60793-1-40<br>Or EIA/TIA 455-78A |
| **3** | Attenuation at Water Peak | As per Section-02 of TS | IEC 60793-1-40<br>Or EIA/TIA 455-78A |
| **4** | Temp. Cycling<br>(Temp dependence of Attenuation) | | IEC 60793-1-52<br>Or EIA/TIA 455-3A, 2 cycles |
| **5** | Attenuation With Bending (Bend Performance) | | IEC 60793-1-47<br>Or EIA/TIA 455-62A |
| **6** | Mode Field dia. | | IEC 60793-1-45 Or EIA/TIA 455-164A/167A/174 |
| **7** | Chromatic Dispersion | | IEC 60793-1-42 Or EIA/TIA 455-168A/169A/175A |

**Table 6-8**
**Type Tests For Optical Fibres**

| S. No. | Test Name | Acceptance Criteria | Test procedure |
|---|---|---|---|
| **8** | Cladding Diameter | | IEC 60793-1-20 Or EIA/TIA 455-176 |
| **9** | Point Discontinuities of attenuation | | IEC 60793-1-40 Or EIA/TIA 455-59 |
| **10** | Core -Clad concentricity error | | IEC 60793-1-20 Or EIA/TIA 455-176 |
| **11** | Fibre Tensile Proof Testing | | IEC 60793-1-31 Or EIA/TIA 455-31B |
| **-End Of table-** | | | |

### 6.3.2.5 Type Tests for OPGW Cables

The type tests to be conducted on the OPGW cable are listed in table 6-9 Type Tests for OPGW Cables. Unless specified otherwise in the technical specifications or the referenced standards, the optical attenuation of the specimen, measured during or after the test as applicable, shall not increase by more than 0.05 dB/Km.

**Table 6-9**
**Type tests for OPGW Cable**

| S. No. | Test Name | Test Description | Test Procedure | |
|---|---|---|---|---|
| **1** | Water Ingress Test | IEEE 1138-2009 | IEEE 1138-2009 (IEC 60794-1-2 Method F5 or EIA/TIA 455-82B) : Test duration : 24 hours | |
| **2** | Seepage of filling compound | IEEE 1138-2009 | IEEE 1138-2009 (EIA/TIA 455-81B) | Preconditioning period:72 hours. Test duration: 24 hours. |

**Table 6-9**
**Type tests for OPGW Cable**

| S. No. | Test Name | Test Description | Test Procedure | |
|---|---|---|---|---|
| **3** | Short Circuit Test | IEEE 1138-2009 | IEEE 1138-2009 | Fibre attenuation shall be continuously monitored and recorded through a digital data logging system or equivalent means.<br>A suitable temperature sensor such as thermocouple shall be used to monitor and record the temperature inside the OPGW tube in addition to monitoring & recording the temperatures between the strands and between optical tube and the strand as required by IEEE 1138.<br>Test shall be conducted with the tension clamps proposed to be supplied. The cable and the clamps shall be visually inspected for mechanical damage and photographed after the test. |
| | | Or<br>IEC60794-4-10 /<br>IEC 60794-1-2 (2003)<br>Method H1 | | Initial temperature during the test shall be greater than or equal to ambient field temperature. |
| **4** | Aeolian Vibration Test | IEEE 1138-2009<br><br>Or<br>IEC60794-4-10 /<br>IEC 60794-1-2, Method E19 | IEEE 1138-2009 | Fibre attenuation shall be continuously monitored and recorded through a digital data logging system or equivalent means.<br>The vibration frequency and amplitude shall be monitored and recorded continuously.<br>All fibres of the test cable sample shall be spliced together in serial for attenuation monitoring.<br>Test shall be conducted with the tension/suspension clamps proposed to be supplied. The cable and the clamps shall be visually inspected for mechanical damage and photographed after the test. |
| **5** | Galloping test | IEEE 1138-2009 | IEEE 1138-2009 | Test shall be conducted with the tension/suspension |

**Table 6-9**
**Type tests for OPGW Cable**

| S. No. | Test Name | Test Description | Test Procedure | |
|---|---|---|---|---|
| | | | | clamps proposed to be supplied. The cable and clamps shall be visually inspected for mechanical damage and photographed after the test. All fibres of the test cable sample shall be spliced together in serial for attenuation monitoring. |
| **6** | Cable Bend Test | Procedure 2 in IEC 60794-1-2 Method E11 | | The short-term and long-term bend tests shall be conducted in accordance with Procedure 2 in IEC 60794-1-2 E11 to determine the minimum acceptable radius of bending without any increase in attenuation or any other damage to the fibre optic cable core such as bird caging, deformation, kinking and crimping. |
| **7** | Sheave Test | IEEE 1138-2009<br>Or<br>IEC 60794-1-2 (2003)<br>Method E18B | IEEE 1138-2009 | Fibre attenuation shall be continuously monitored and recorded through a digital data logging system or equivalent means.<br>The Sheave dia. shall be based on the pulling angle and the minimum pulley dia employed during installation. All fibres of the test cable sample shall be spliced together in serial for attenuation monitoring. |
| **8** | Crush Test | IEEE 1138-2009 | IEEE 1138-2009<br><br>(IEC 60794-1-2, Method E3/ EIA/TIA 455-41B) | The crush test shall be carried out on a sample of approximately one (1) metre long in accordance with IEC 60794-1-2 E3. A load equal to 1.3 times the weight of a 400-metre length of fibre optic cable shall be applied for a period of 10 minutes. A permanent or temporarily increase in optical attenuation value greater than 0.1 dB change in sample shall constitute failure. The load shall be further increased in small |

**Table 6-9**
**Type tests for OPGW Cable**

| S. No. | Test Name | Test Description | Test Procedure | |
|---|---|---|---|---|
| | | | | increments until the measured attenuation of the optical waveguide fibres increases and the failure load recorded along with results. |
| **9** | Impact Test | IEEE 1138-2009 | IEEE 1138-2009 (IEC 60794-1-2 E4/ EIA/TIA 455-25B) | The impact test shall be carried out in accordance with IEC 60794-1-2 E4. Five separate impacts of 0.1-0.3kgm shall be applied. The radius of the intermediate piece shall be the reel drum radius ± 10%. A permanent or temporary increase in optical attenuation value greater than 0.1 dB/km change in sample shall constitute failure. |
| **10** | Creep Test | IEEE 1138-2009 | IEEE 1138-2009 | As per Aluminium Association Method, the best-fit straight line shall be fitted to the recorded creep data and shall be extrapolated to 25 years. The strain margin of the cable at the end of 25 years shall be calculated. The time when the creep shall achieve the strain margin limits shall also be calculated. |
| **11** | Fibre Strain Test | IEEE 1138-1994 | IEEE 1138-1994 | |
| **12** | Strain Margin Test | IEEE 1138-2009 | IEEE 1138-2009 | |
| **13** | Stress strain Test | IEEE 1138-2009 | IEEE 1138-2009 | |
| **14** | Cable Cut-off wavelength Test | IEEE 1138-1994 | IEEE 1138-1994 | |
| **15** | Temperature Cycling Test | IEEE 1138-2009 | IEEE 1138-2009<br>Or IEC 60794-1-2, Method F1 | |
| **16** | Corrosion (Salt Spray) | EIA/TIA 455-16A | | |

**Table 6-9**
**Type tests for OPGW Cable**

| S. No. | Test Name | Test Description | Test Procedure |
|---|---|---|---|
| | Test | | |
| **17** | Tensile Performance Test | IEC 60794-1-2 E1 / EIA/TIA 455-33B | The test shall be conducted on a sample of sufficient length in accordance with IEC 60794-1-2 E1. The attenuation variation shall not exceed 0.05 dB/Km up to 90% of RTS of fibre optic cable.<br>The load shall be increased at a steady rate up to rated tensile strength and held for one (1) minute. The fibre optic cable sample shall not fail during the period. The applied load shall then be increased until the failing load is reached and the value recorded. |
| **18** | Fault Current/ Lightning Test | IEC 60794-4-10 /<br>IEC 60794-1-2 (2003) | The OPGW cable construction shall be tested in accordance with IEC 60794-1-2, Method H2 for Class 1. |
| **19** | DC Resistance Test (IEC 60228) | On a fibre optic cable sample of minimum 1 metre length, two contact clamps shall be fixed with a predetermined bolt torque. The resistance shall be measured by a Kelvin double bridge by placing the clamps initially zero metre and subsequently one metre apart. The tests shall be repeated at least five times and the average value recorded after correcting at 20°C. | |
| **-End Of Table-** | | | |

### 6.3.2.6 Type Test on OPGW Cable Fittings

The type tests to be conducted on the OPGW Cable fittings and accessories are listed below:

**(i) Mechanical Strength Test for Suspension/Tension Assembly**

Applicable Standards: IEC 61284, 1997.

Suspension Assembly

The armour rods /reinforcement rods are assembled on to the approved OPGW using the Installation Instructions to check that the assembly is correctly fitted and is the same that will be carried out during installations.

**Part 1:**
The suspension assembly shall be increased at a constant rate up to a load equal to 50% of the specified minimum Failure Load increased and held for one minute for the test rig to stabilise. The load shall then be increased at a steady rate to 67% of the minimum Failure Load and held for five minutes. The angle between the cable, the Suspension Assembly and the horizontal shall not exceed $16^{o}$. This load shall then be removed in a controlled manner and the Protection Splice disassembled. Examination of all the components shall be made and any evidence of visual deformation shall be documented.

**Part 2:**
The Suspension clamp shall then be placed in the testing machine. The tensile load shall gradually be increased up shall gradually be increased up to 50% of the specified Minimum Failure Load of the Suspension Assembly and held for one minute for the Test Rig to stabilise and the load shall be further increased at a steady rate until the specified minimum Failure Load is reached and held for one minute. No fracture should occur during this period. The applied load shall then be increased until the failing load is reached and the value shall be documented.

**Tension Assembly**

The Tension Assembly is correctly fitted and is the same that will be carried out during installations.

**Part 1:**
The tension assembly (excluding tension clamp) shall be increased at a constant rate up to a load equal to 50% of the specified minimum Failure Load increased at a constant rate and held for one minute for the test rig to stabilise. The load shall then be increased at a steady rate to 67% of the minimum Failure Load and held for five minutes. This load shall then remove in a controlled manner and the Tension Assembly disassembled. Examination of the Tension Dead-End and associated components shall be made and any evidence of visual deformation shall be documented.

**Part 2:**
The Tension Dead-End and associated components shall then be reassembled and bolts tightened as before. The tensile load shall gradually be increased up shall gradually be increased up to 50% of the specified Minimum Failure Load of the Tension Assembly and held for one minute for the Test Rig to stabilise and the load shall be further increased at a steady rate until the specified minimum Failure Load is reached and held for one minute. No fracture should occur during this period. The applied load shall then be increased until the failing load is reached and the value shall be documented.

Acceptance Criteria for Tension/Suspension Assembly:

- No evidence of binding of the Nuts or Deformation of components at end of Part 1 of Test.
- No evidence of Fracture at the end of one minute at the minimum failure load during Part 2 of the Test.

Any result outside these parameters shall constitute a failure.

**(ii) Clamp Slip Strength Test for Suspension Assembly**

The suspension assembly shall be vertically suspended by means of a flexible attachment. A suitable length fibre optical cable shall be fixed in the clamps. Once the Suspension Clamp has been assembled, the test rig is tensioned to 1 kN and the position scale on the recorder 'zeroed'. The test rig is then tensioned to 2.5 kN and the relative positions of the Reinforcing Rods, Armour Rods and Suspension Clamp shall be marked by a suitable means to confirm any slippage after the test has been completed. The relative positions of the helical Armour Rods and associated Reinforcing Rods at each end shall be marked and also 2 mm relative position between clamp body and Armour Rods shall be marked on one side. The load shall be increased to 12 kN at a loading rate of 3 kN/min and held for one minute. At the end of this one minute period, the relative displacement between clamp body and the armour rods shall be observed. If the slippage is 2 mm or above, the test shall be terminated. Otherwise, at the end of one minute the position of the clamp body and 2 mm. relative positions between clamp body and armour rods shall be marked on the other side. After the one minute pause, the load shall be further increased at a loading rate of 3 kN/min, and recording of load and displacement shall continue until either the relative Position displacement between clamp body and armour rods reaches more than 2 mm or the load reaches the maximum slip load of 17 kN. On reaching either of the above values the test is terminated. Visual examination of all paint marks shall be recorded, and a measurement of any displacement recorded in the Table of Results.

**Acceptance Criteria:**

The Suspension Clamp has passed the Slip Test if the following conditions are met:

- No slippage* shall occur at or below the specified minimum slip load.

  * Definition of no slippage in accordance with IEC 61284, 1997:- Any relative movement less than 2 mm is accepted. The possible couplings or elongations produced by the cable as a result of the test itself are not regarded as slippage.

- Slippage shall occur between the specified maximum and minimum slip load of 12 - 17 kN.

- There shall be no slippage of the Reinforcing Rods over the cable, and no slippage of the Armour Rods over the Reinforcing Rods.

- The relative movement (i.e. more than 2 mm between Armour Rods & Clamp body) between minimum 12 kN and maximum slip 17 kN, shall be considered as slip.

- The Armour Rods shall not be displaced from their original lay or damaged**.

  ** Definition of no damage in accordance with convention expressed in IEC 61284: 1997 no damage, other than surface flattening of the strands shall occur.

Any result outside these parameters is a failure.

**(iii) Slip Strength Test of Tension Clamp**

Tension clamps shall be fitted on a 8 m length of fibre optic cable on both ends. The

assembly shall be mounted on a tensile testing machine and anchored in a manner similar to the arrangement to be used in service. A tensile load shall gradually be applied up to 20 % of the RTS of OPGW. Displacement transducers shall be installed to measure the relative movement between the OPGW relative to the Reinforcing Rods and Tension Dead -End relative to Reinforcing Rods. In addition, suitable marking shall be made on the OPGW and Dead-End to confirm grip. The load shall be gradually increased at a constant rate up to 50 % of the UTS and the position scale of the recorder is zeroed. The load shall then gradually increased up to 95 % of the UTS and maintained for one minute. After one minute pause, the load shall be slowly released to zero and the marking examined and measured for any relative movement.

**Acceptance Criteria:**

- No movement* shall occur between the OPGW and the Reinforcing Rods, or between the Reinforcing Rods and the Dead-End assembly.
- No failure or damage or disturbance to the lay of the Tension Dead-End, Reinforcing Rods or OPGW.

* Definition of no movement as defined in IEC 61284: Any relative movement less than 2 mm is accepted. The possible couplings or elongations produced by the conductor as a result of the test itself are not regarded as slippage.

Any result outside these parameters shall constitute a failure.

**(iv) Grounding Clamp and Structure Mounting Clamp Fit Test**

For structure mounting clamp, one series of tests shall be conducted with two fibre optic cables installed, one series of tests with one fibre optic cable installed in one groove, and one series of tests with one fibre optic cable in the other groove. Each clamp shall be installed including clamping compound as required on the fibre optic cable. The nut shall be tightened on to the bolt by using torque wrench with a torque of 5.5 kgm or supplier's recommended torque and the tightened clamp shall be held for 10 minutes. After the test remove the fibre optic cable and examine all its components for distortion, crushing or breaking. Also the fibre optic cable shall be checked to ensure free movement within the core using dial callipers to measure the diameter of the core tube. The material shall be defined as failed if any visible distortion, crushing, cracking or breaking of the core tube is observed or the fibre optic cable within the core tube is not free to move, or when the diameter of the core tube as measured at any location in the clamped area is more than 0.5 mm larger or smaller of the core diameter as measured outside the clamped area.

**(v) Structure Mounting Clamp Strength Test**

The clamp and mounting assembly shall be assembled on a vertical 200 mm x 200 mm angle and a short length of fibre optic cable installed. A vertical load of 200 kg shall be applied at the end of the mounting clamp and held for 5 minutes. Subsequently, the load shall be increased to 400 kg and held for 30 seconds. Any visible distortion, slipping or breaking of any component of the mounting clamp or assembly shall constitute failure.

### 6.3.2.7 Type Test on Vibration Damper

**(a) Dynamic Characteristic Test**

The damper shall be mounted with its clamp tightened with torque recommended by the manufacturer on shaker table capable of simulating sinusoidal vibrations for Critical Aeolian Vibration frequency band 0.18/d to 1.4/d – where d is the OPGW cable diameter in meters.The damper assembly shall be vibrated vertically with a ±1 mm amplitude from 5 to 15 Hz frequency and beyond 15 Hz at 0.5 mm to determine following characteristics with the help of suitable recording instruments.

(i) Force Vs frequency

(ii) Phase angle Vs frequency

(iii) Power dissipation Vs frequency

The Force Vs frequency curve shall not show steep peaks at resonance frequencies and deep troughs between the resonance frequencies. The resonance frequencies shall be suitably spread within the Aeolian vibration frequency-band between the lower and upper dangerous frequency limits determined by the vibration analysis of fibre optic cable without dampers.

Acceptance criteria for vibration damper:

(i) The above dynamic characteristics test on five damper shall be conducted.
(ii) The mean reactance and phase angle Vs frequency curves shall be drawn with the criteria of best fit method.
(iii) The above mean reactance response curve should lie within following limits:
V.D. for OPGW - 0.060 f to 0.357 f kgf/mm* Where f is frequency in Hz.
(iv) The above mean phase angle response curve shall be between $25^{o}$ to $130^{o}$ within the frequency range of interest.
(v) If the above curve lies within the envelope, the damper design shall be considered to have successfully met the requirement.
(vi) Visual resonance frequencies of each mass of damper is to be recorded and to be compared with the guaranteed values.

**(b) Vibration Analysis**

The vibration analysis of the fibre optic cable shall be done with and without damper installed on the span. The vibration analysis shall be done on a digital computer using energy balance approach. The following parameters shall be taken into account for the purpose of analysis.

(i) The analysis shall be done for single fibre optic cable without armour rods. The tension shall be taken as 25% of RTS of fibre optic cable for a span ranging from 100 m to 1100 m.

(ii) The self damping factor and flexural stiffness (EI) for fibre optic cable shall be calculated on the basis of experimental results. The details to experimental analysis with these data shall be furnished.

(iiiThe power dissipation curve obtained from Damper Characteristics Test shall beused for analysis with damper.

(iv) Examine the Aeolian Vibration level of the fibre optic cable with and without vibration damper installed at the recommended location or wind velocity ranging from 0 to 30 Km per hour, predicting amplitude, frequency and vibration energy input.

(v) From vibration analysis of fibre optic cable without damper, antinode vibration amplitude and dynamic strain levels at clamped span extremities as well as antinodes shall be examined and thus lower and upper dangerous frequency limits between which the Aeolian vibration levels exceed the specified limits shall be determined.

(vi) From vibration analysis of fibre optic cable with damper(s) installed at the recommended location, the dynamic strain level at the clamped span extremities, damper attachment point and the antinodes on the fibre optic cable shall be determined. In addition to above damper clamp vibration amplitude and antinodes vibration amplitudes shall also be examined.

The dynamic strain levels at damper attachment point, clamped span extremities and antinodes shall not exceed the specified limits. The damper clamp vibration amplitude shall not be more than that of the specified fatigue limits.

**Fatigue Tests**

**(i) Test Set Up**

The clamp slip and fatigue tests shall be conducted on a laboratory set up with a minimum effective span length of 30m. The fibre optic cable shall be tensioned at 25% of RTS of fibre optic cable and shall not be equipped with protective armour rods at any point.

Constant tension shall be maintained within the span by means of lever arm arrangement. After the fibre optic cable has been tensioned, clamps shall be installed to support the fibre optic cable at both ends and thus influence of connecting hardware fittings are eliminated from the free span. The clamps shall not be used for holding the tension on the fibre optic cable. There shall be no loose parts, such as suspension clamps, U bolts, on the test span supported between clamps mentioned above. The span shall be equipped with vibration inducing equipment suitable for producing steady standing vibration. The inducing equipment shall have facilities for step less speed control as well as step less amplitude arrangement. Equipment shall be available for measuring the frequency, cumulative number of cycles and amplitude of vibration at any point along the span.

**(ii) Fatigue Test**

The vibration damper shall be installed on the test span with the manufacturer's specified tightening torque. It shall be ensured that the damper shall be kept minimum three loops away from the shaker to eliminate stray signals influencing damper movement.

The damper shall then be vibrated at the highest resonant frequency of each damper mass. For dampers involving torsional resonant frequencies, tests shall be done at torsional modes also in addition to the highest resonant frequencies at vertical modes. The resonance frequency shall be identified as the frequency at which each damper mass vibrates with the maximum amplitude on itself. The amplitude of vibration of the damper clamp shall be maintained not less than ±25/f mm where f is the frequency in Hz.

The test shall be conducted for minimum ten million cycles at each resonant frequency mentioned above. During the test, if resonance shift is observed, the test frequency shall be tuned to the new resonant frequency.

The clamp slip test as mentioned herein above shall be repeated after fatigue tests without retorquing or adjusting the damper clamp, and the clamp shall withstand a minimum load equal to 80% of the slip strength for a minimum duration of one minute.

After the above tests, the damper shall be removed from fibre optic cable and subjected to dynamic characteristics test. There shall not be any major deterioration in the characteristics of the damper. The damper then shall be cut open and inspected. There shall not be any broken, loose, or damaged part. There shall not be significant deterioration or wear of the damper. The fibre optic cable under clamp shall also be free from any damage.

For purposes of acceptance, the following criteria shall be applied:

(1) There shall not be any resonant frequency shift before and after test by more than ±20%.

(j)

(2) The power dissipation of the damper before and after test at the individual resonant frequencies do not differ by more than 20%.

### 6.3.2.8 Type Tests for Splice Enclosures (Joint Box)

Following Type tests shall be demonstrated on the Splice Enclosure(s) (Splice Enclosure/Box). For certain tests, lengths of the fibre optic cable shall be installed in the splice box, and the fibres must be spliced and looped in order to simulate conditions of use. The attenuation of the fibres shall be measured, during certain tests, by relevant Fibre Optic Test Procedures (EIA/TIA 455 or IEC 60794-1 procedures).

#### (i) Temperature Cycling Test

FO cable is installed in the splice enclosure and optical fibres spliced and looped. The box must be subjected to 5 cycles of temperature variations of -40°C to +65°C with a dwell time of at least 2 hours on each extreme.

Fibre loop attenuation shall be measured in accordance with EIA 455-20 / IEC 60794-1-C10. The variation in attenuation shall be less than ±0.05dB. The final humidity level, inside the box, shall not exceed the initial level, at the closing of the box.

**(ii) Humid Heat test**

The sealed splice enclosure, with fibres spliced and looped inside, must be subjected to a temperature of +55°C ±2°C with a relative humidity rate of between 90% and 95% for 5 days. The attenuation variation of the fibres during the duration of the test shall be less than ±0.05dB, and the internal humidity rate measured, less than 2%.

**(iii) Rain Withstand Test / Water Immersion test**

The splice enclosure with optical fibres cable installed and fibres spliced fixed, shall be subjected to 24 hours of simulated rain in accordance with IEC 60060 testing requirements. No water seepage or moisture shall be detected in the splice enclosure. The attenuation variation of the fibres after the test shall be less than ±0.05dB.

**(iv) Vibration Test**

The splice enclosure, with fibres united inside, shall be subjected to vibrations on two axes with a frequency scanning of 5 to 50 Hz. The amplitude of the vibrations shall be constant at 0.450mm, peak to peak, for 2 hours, for each of the vibrations' axes. The variation in attenuation, of the fibres, shall be less than ±0.05dB. The splice enclosure shall be examined for any defects or deformation. There shall be no loosening or visible damage of the FO cable at the entry point.

**(v) Bending and Torsion test**

The splice enclosure, with fibres spliced inside, shall be firmly held in place and be subjected to the following sequence of mechanical stresses on the cable:

a) 3 torsion cycles of ±180° shall be exercised on the cable. Each cycle shall be less than one minute.

b) 3 flexure cycles of the cable, of ±180° with one cycle less than one minute.

The variation in the attenuation, of the fibres, shall be less than ±0.05dB. The cables connection ring shall remain securely fixed to the box with the connection maintained firmly. No defects/fissures shall be noted on the joint ring or on the splice enclosure

**(vi) Tensile test**

The splice enclosure with cable fixed to the boxes shall be subjected to a minimum tension of 448 N for a period of two minutes. No fissure shall be noted in the connections or on the box.

**(vii) Drop Test**

With 2 lengths of 11 metres of cable fixed to the box, it shall be dropped five times from a height of 10 metres. There shall be no fissure, at all, of the box, and the connections shall remain tight. The test surfaces shall be carried out in accordance with IEC 60068-2-32.

### 6.3.2.9 Type Tests for Fibre Optic Approach Cable

The type tests to be conducted on the Fibre Optic Approach cable are listed in table 6-10:Type Tests for Fibre Optic Approach Cable. Unless specified otherwise in the technical specifications or the referenced standards, the optical attenuation of the specimen, measured during or after the test as applicable, shall not increase by more than 0.05 dB/Km.

**Table 6-10:**
**Type Tests Fibre Optic Approach Cable**

| S.NO. | Test Name | Test Procedure |
|---|---|---|
| 1 | Water Ingress Test | (IEC 60794-1-F5 / EIA 455-82B) Test duration : 24 hours |
| 2 | Seepage of filling compound | (EIA 455-81A) Preconditioning : 72 hours, Test duration : 24 hours. |
| 3 | Crush Test | (IEC 60794-1-E3/ EIA 455-41) |
| 4 | Impact Test | (IEC-60794-1-E4/ EIA 455-25A) |
| 5 | Stress strain Test | (EIA 455-33A) |
| 6 | Cable Cut-off wavelength Test | (EIA 455-170) |
| 7 | Temperature Cycling Test | (IEC60794-1-F1/EIA-455-3A) – 2 cycles |
| -End Of Table- | | |

#### 6.3.2.9.1 Impact Test

The Impact test shall be carried out in accordance with IEC:60794-1-E4. Five separate impacts of 2.0 kg shall be applied at different locations. The radius of the intermediate piece shall be the reel drum radius ± 10%. A permanent or temporary increase in optical attenuation value greater than 0.05 dB/km shall constitute failure.

### 6.4 Factory Acceptance Tests

Factory acceptance tests shall be conducted on randomly selected final assemblies of all equipment to be supplied. Factory acceptance testing shall be carried out on OPGW Cable and associated hardware & fittings, Approach Cable, Joint Box, FODP, SDH Equipments, associated line & tributary cards, Termination Equipments ( Drop/Insert, DACS, associated Subscriber Line Interface Cards etc), Network Management System, radio equipment, DCPS, Battery etc. and all other items for which price has been identified separately in the Bid Price Schedules.

Material shall not be shipped to the Employer until required factory tests are completed

satisfactorily, all variances are resolved, full test documentation has been delivered to the Employer, and the Employer has issued Material Inspection & Clearance Certificate (MICC). Successful completion of the factory tests and the Employer approval to ship, shall in no way constitute final acceptance of the system or any portion thereof. These tests shall be carried out in the presence of the Employer's authorised representatives unless waival for witnessing by Employer's representatives is intimated to the contractor.

Factory acceptance tests shall not proceed without the prior delivery to and approval of all test documentation by the Employer.

The factory acceptance test shall demonstrate the technical characteristics of the equipment in relation to this specifications and approved drawings and documents. List of factory acceptance tests for Fibre Optic Transmission system, Termination Equipment Sub-system , NMS, DCPS and Battery are given in specified Tables in this section. This list of factory acceptance tests shall be supplemented by the Contractor's standard FAT testing program. The factory acceptance tests for the other items shall be proposed by the Contractor in accordance with technical specifications and Contractor's (including Sub-Contractor's / supplier's) standard FAT testing program. In general the FAT for other items shall include at least: Physical verification, demonstration of technical characteristics, various operational modes, functional interfaces, alarms and diagnostics etc.

For Test equipment & clock, FAT shall include supply of proper calibration certificates, demonstration of satisfactory performance, evidence of correct equipment configuration and manufacturer's final inspection certificate/ report.

### 6.4.1 Sampling for FAT

From each batch of equipment presented by the Contractor for Factory acceptance testing, the Employer shall select random sample(s) to be tested for acceptance. Unless otherwise agreed, all required FAT tests in the approved FAT procedures, shall be performed on all samples. The Sampling rate for the Factory acceptance tests shall be minimum 10% of the batch size (minimum 1) for all items. The physical verification shall be carried out on 100% of the offered quantities as per the approved FAT procedure. In case any of the selected samples fail, the failed sample is rejected and additional 20% samples shall be selected randomly and tested. In case any sample from the additional 20% also fails the entire batch may be rejected. In case a number of equipments are required for demonstration of the performance of any equipment during FAT, the sample size shall be taken as that number of equipments which are necessary to demonstrate the performance, irrespective of the percentage.

For the OPGW/Aerial cable hardware fittings & accessories, the minimum sampling rate, and batch acceptance criteria shall be as defined in IS 2486.

The Sampling rate for the Factory acceptance tests shall be 10% of the batch size (minimum 2) for FO cable drums, FODPs, Joint box and other similar items.
Since FAT testing provides a measure of assurance that the Quality Control objectives are being met during all phases of production, the Employer reserves the right to require the Contractor to investigate and report on the cause of FAT failures and to suspend further

testing/ approvals until such a report is made and remedial actions taken, as applicable.

### 6.4.2 Production Testing

Production testing shall mean those tests which are to be carried out during the process of production by the Contractor to ensure the desired quality of end product to be supplied by him. The production tests to be carried out at each stage of production shall be based on the Contractor's standard quality assurance procedures. The production tests to be carried out shall be listed in the Manufacturing Quality Plan (MQP), along with information such as sampling frequency, applicable standards, acceptance criteria etc.

The production tests would normally not be witnessed by the Employer. However, the Employer reserves the right to do so or inspect the production testing records in accordance with Inspection rights specified for this contract.

### 6.4.3 FAT of Communication Equipments

**Table 6-11:**
**Factory Acceptance Testing for Fibre Optic Transmission System**

| Item: | Description: |
|---|---|
| **1.** | Physical inspection for conformance to DRS, BOQ, drawings and appearance of equipment |
| **2.** | Optical output power |
| **3.** | Transmitter lightwave spectral analysis |
| **4.** | Low receive level threshold |
| **5.** | Generation of bit error rate curve |
| **6.** | Measurement of analog and digital service channel parameters as well as service channel functionality |
| **7.** | Performance of supervision, alarm, Craftsperson interface, diagnostics, loop backs etc. |
| **8.** | Electrical interface tests which include: output and input jitter, bit error rate, pulse shape, cable compensation, and line rate tolerance for multiplexers |
| **9.** | At a minimum tests on Ethernet interface shall include demonstration of ping test, throughput test, Latency test, Packet Loss test as per RFC 2544 |
| **11.** | Simulation of failure conditions and failover of each redundant unit. |
| **12.** | Test of spare card slots |

**Table 6-11:**

**Factory Acceptance Testing for Fibre Optic Transmission System**

| | |
|---|---|
| **13.** | Checks of power supply/converter voltage margins |
| **14.** | Random inspections to verify the accuracy of documentation |
| **15.** | Test of spare parts/modules/cards as per applicable tests |

**Table 6-12**
**Factory Acceptance Testing Requirements for Termination Equipment (MUX & DACS)**

| Item | Description: |
|---|---|
| **1.** | Physical Inspection for conformance to DRS, BOQ, drawings and appearance of equipment |
| **2.** | Performance of supervision, alarm, control and switching systems, diagnostics, loopbacks, Craftsperson interface etc. |
| **3.** | Electrical interface tests which include: output and input jitter, bit error rate, pulse shape, cable compensation, and line rate tolerance for the channel banks/low-level multiplexers |
| **4.** | Framing, signaling, and operational and maintenance tests consistent with applicable ITU-T requirements |
| **5.** | Simulation of failure conditions and failover of each redundant unit |
| **6.** | Test of spare card slots and test of spare parts/modules/cards as per applicable tests |
| **7.** | Checks of power supply/converter voltage margins and short circuit and overvoltage protection |
| **8.** | Random inspections to verify the accuracy of documentation |

| **Table 6-13**<br>**FAT on NMS** | |
|---|---|
| 1 | Physical inspection of NMS hardware for conformance to approved BoQ, DRS & drawing |
| 2 | Test to demonstrate the expansion capability of the NMS system |
| 3 | Test to demonstrate the functionality of North bound interface |
| 4 | Testing of NMS to demonstrate proper operation of all functions: Configuration Management, Performance Management, Fault Management and Security Management. All standard features and required customization of the NMS shall be demonstrated for proper functioning. |

### 6.4.4 FAT/SAT of DCPS

The factory/site tests to be carried out on each DCPS system/module in the factory and site are listed respectively in Table below.

**Table-6-14**

**Lists of tests for FAT/SAT of DCPS**

| S.No. | Test | FAT | SAT |
|---|---|---|---|
| **Tests on DCPS System** | | | |
| 1. | Mechanical & Visual Check Tests | √ | √ |
| 2. | Insulation Test. | √ | |
| 3. | High Voltage Withstand Test | √ | |
| 4. | Switch On Test | √ | √ |
| 5. | DCPS Low voltage & High voltage limits check Test | √ | √ |
| 6. | Pre-alarm test for Battery Voltage Low | √ | √ |
| 7. | Battery Low Voltage Disconnect Level Test | √ | √ |
| 8. | AC Input Low and High voltage limits check Test | √ | |
| 9. | Rectifier Fail Alarm Test | √ | √ |
| 10. | Voltage Regulation Test | √ | |
| 11. | Current Sharing Test | √ | |
| 12. | Total Output Power Test | √ | √ |
| 13. | Hot Plug In Test ( if applicable ) | √ | √ |
| 14. | Calibration & Parameter settings | √ | √ |
| 15. | Automatic Float cum Boost Charge Mode Change Over Test | √ | √ |
| 16. | Battery Path Current Limiting Test | √ | √ |
| 17. | Battery Charging and full load Current Test | √ | √ |
| 18. | Total Harmonic distortion Test | √ | |
| 19. | Burn in Test at 50 ° C (for 8 hrs duration) | √ | |
| **Tests on SMPS module** | | | |
| 20 | Mechanical & Visual Check Test | √ | |
| 21 | Module-On Test | √ | |
| 22 | Input low/high voltage cut-off test | √ | |
| 23 | Voltage Drop Test | √ | |
| 24 | Voltage Regulation Test | √ | |
| 25 | Power Output & Current Limit Test | √ | |
| 26 | DC High Voltage Test | √ | |
| 27 | O/P Voltage Ripple Test | √ | |
| 28 | Psophometric Noise Test | √ | |
| 29 | Efficiency Test | √ | |
| 30 | Power Factor | √ | |
| 31. | Input Current Limit | √ | |
| 32. | Input AC Frequency Range Test | √ | |
| 33. | Rectifier Dynamic Response | √ | |
| 34. | Output Short Circuit Test | √ | |
| 35. | Hold up Time Test | √ | |

### 6.4.5 Factory Acceptance Tests on Optical Fibre to be supplied with OPGW

The factory acceptance tests listed in table below are applicable for the Optical fibres to be supplied. The listed tests follow testing requirements set forth in IEEE standard 1138/IEC 60794. The referenced sections specify the detailed test description. The acceptance norm

shall be as specified in the above mentioned IEEE standards unless specified otherwise in the technical specifications.

**Table 6-15**
**Factory Acceptance Tests for Optical Fibres: Optical Tests**

| S. No. | Test Name | Acceptance Criteria | Test procedure |
|---|---|---|---|
| **1** | Attenuation Coefficient | TS Vol II ,Table 2-1(a) | EIA/TIA 455- 78A |
| **2** | Point Discontinuities of attenuation | TS Vol II, Section 2.1.1.2 | EIA/TIA 455-59 |
| **3** | Attenuation at Water Peak | TS Vol II ,Table 2-1(a) | EIA/TIA 455- 78A |
| **4** | Chromatic Dispersion | | EIA/TIA 455-168A/169A/175A |
| **5** | Core – Clad Concentricity Error | | EIA/TIA 455-/176 |
| **6** | Cladding diameter | | EIA/TIA 455-176 |
| **7** | Fibre Tensile Proof Testing | | EIA/TIA 455-31B |
| **-End of table-** | | | |

The test report for the above tests for the fibers carried out by the Fiber Manufacturer and used in the OPGW cables shall be shown to the inspector during OPGW cable FAT and shall be submitted along with the OPGW cable FAT report.

### 6.4.6 Factory Acceptance Test on OPGW Cable

The factory acceptance tests for OPGW cable specified below in Table follow the requirements set forth in IEEE standard 1138 / IEC 60794. The FAT shall be carried out on 10% of offered drums in each lot as specified in technical specifications and the optical tests shall be carried out in all fibres of the selected sample drums. The Rated Tensile Strength test shall be carried out on one sample in each lot.

**Table 6-16**
**Factory Acceptance Tests on OPGW**
**Applicable standard: IEEE 1138 / IEC 60794**

| S. No. | Factory Acceptance Test on Manufactured OPGW |
|---|---|
| **1** | Attenuation Co-efficient at 1310 nm and 1550 nm |
| **2** | Point discontinuities of attenuation |
| **3** | Visual Material verification and dimensional checks as per approved DRS/Drawings |
| **4** | Rated Tensile Strength |
| **5** | Lay Length Measurements |

### 6.4.7 Factory Acceptance Test on OPGW Fittings

The factory acceptance tests for OPGW Fittings as specified below in Table 6-17. The sampling plan shall be as per relevant standard:

**Table 6-17**
**Factory Acceptance Tests On OPGW Fittings**

| S. No. | Factory Acceptance Test |
|---|---|
| **Suspension Assembly** | |
| 1 | UTS/Mechanical Strength of the assembly |
| 2 | Clamp Slip Test |
| 3 | Visual Material verification and dimensional checks as per approved DRS/Drawings |
| 4 | Mechanical strength of each component |
| 5 | Galvanising test |
| **Tension Assembly** | |
| 6 | Clamp Slip Strength test |
| 7 | Visual Material verification and dimensional checks as per approved DRS/Drawings |
| 8 | Mechanical strength of each component |
| 9 | Galvanising test |
| **Vibration Damper** | |
| 10 | Galvanising test on damper, masses and messenger wires |
| 11 | Damper response (resonant frequencies) |
| 12 | Clamp Slip test |
| 13 | Strength of messenger wires |
| 14 | Attachments of weights to messenger cable |
| 15 | Attachments of clamps to messenger cable |
| 16 | Clamp bolt tightening test |
| 17 | Clamp bolt torque test |
| 18 | Dynamic characteristic test |
| 19 | Visual Material verification and dimensional checks as per approved DRS/Drawings |
| **Structure Mounting Clamp** | |
| 14 | Clamp fit test |
| 15 | Clamp Strength test |
| 16 | Visual Material verification and dimensional checks as per approved DRS/Drawings |
| **End of Table** | |

### 6.4.8 Factory Acceptance Test on Approach Cable

The factory acceptance tests for Approach Cable specified below in Table 6-18:

**Table 6-18**
**Factory Acceptance Tests On Approach Cable**

| S. No. | Factory Acceptance Test |
|---|---|
| 1 | Attenuation Co-efficient at 1310 nm and 1550 nm |
| 2 | Point discontinuities of attenuation |
| 3 | Visual Material verification and dimensional checks as per approved DRS/Drawings |

### 6.4.9 Factory Acceptance Test on Splice Enclosure (Joint Box) /FODP

The factory acceptance tests for Splice Enclosures/FODP as specified below in Table:

**Table 6-19**
**Factory Acceptance Tests on Splice Enclosures (Joint Box)/FODP**

| S. No. | Factory Acceptance Test |
|---|---|
| 1 | Visual check of Quantities and Specific Component Number for each component of Splice Enclosure/FODP and dimensional checks against the approved drawings. |

### 6.4.10 Factory Acceptance Test on Test Equipment, Pigtail & other items

As per technical specification and approved DRS/Documents.

### 6.5 Site Acceptance Tests

The Contractor shall be responsible for the submission of all equipment & test equipment supplied in this contract for site tests and inspection as required by the Employer. All equipment shall be tested on site under the conditions in which it will normally operate.

The tests shall be exhaustive and shall demonstrate that the overall performance of the contract works satisfies every requirement specified. At a minimum Site Acceptance Testing requirement for FO cable, Telecom equipment, NMS etc. is outlined in following section. This testing shall be supplemented by the Contractor's standard installation testing program, which shall be in accordance with his quality plan(s) for FO & Telecom equipment

installation. The tests to be conducted during SAT of Battery & DCPS are specified in respective Tables in this section.

During the course of installation, the Employer shall have full access for inspection and verification of the progress of the work and for checking workmanship and accuracy, as may be required. On completion of the work prior to commissioning, all equipment shall be tested to the satisfaction of the Employer to demonstrate that it is entirely suitable for commercial operation.

### 6.5.1 Minimum Site Acceptance Testing Requirement for FO Cabling

Prior to installation, every spooled fibre optic cable segment shall be tested for compliance with the Pre-shipment data previously received from the manufacturer. This requirement will preclude the installation of out of specification cable segments that may have been damaged during shipment.

#### 6.5.1.1 Phases of Site Acceptance Testing

SAT shall be carried out link by link from FODP to FODP. SAT may be performed in parts in case of long links.

The tests, checks, adjustments etc conducted by the Contractor prior to offering the equipment for SAT shall be called Pre-SAT activities. The Pre-SAT activities shall be described in the installation manuals and Field Quality Plan documents.

Sag and tension of OPGW shall generally be as per approved sag-tension chart and during installation, sag and tension of OPGW shall be documented. Upon completion of a continuous cable path, all fibres within the cable path shall be demonstrated for acceptance of the cable path. Fibre Optic cable site testing minimum requirements are provided in Table 6-20(a) through 6-20(c) below.

**Table 6-20(a)**
**Fibre Optic Cable Pre-Installation Testing**

| Item: | Description: |
|---|---|
| 1. | Physical Inspection of the cable assembly for damage |
| 2. | Optical fibre continuity and fibre attenuation with OTDR at 1550 nm |
| 3. | Fibre Optic Cable length measurement using OTDR |

**Table 6-20(b)**
**Fibre Optic Cable Splicing Testing**

| Item: | Description: |
|---|---|
| | |

| | |
|---|---|
| **1.** | Per splice bi-directional average attenuation with OTDR |
| **2.** | Physical inspection of splice box/enclosure for proper fibre / cable routing techniques |
| **3.** | Physical inspection of sealing techniques, weatherproofing, etc. |

**Table 6-20(c)**
**Fibre Optic Cable Commissioning Testing**

| Item: | Description: |
|---|---|
| 1. | End to End (FODP to FODP) bi-directional average attenuation of each fibre at 1310 nm and 1550 nm by OTDR. |
| 2. | End to End (FODP to FODP) bi-directional average attenuation of each fibre at 1310 nm and 1550 nm by Power meter. |
| 3. | Bi-directional average splice loss by OTDR of each splice as well as for all splices in the link (including at FODP also). |
| 4. | Proper termination and labelling of fibres & fibre optic cables at FODP as per approved labelling plan. |
| **-End of Table-** | |

### 6.5.2 Phases for Site Acceptance Testing for Communication Equipments

The SAT shall be completed in following phases:

#### 6.5.2.1 Installation Testing

The field installation test shall be performed for all equipment at each location. If any equipment has been damaged or for any reason does not comply with this Specification, the Contractor shall provide and install replacement parts at its own cost and expense.

In the installation test report, the Contractor shall include a list of all hardware or components replaced or changed between the completion of factory tests and the start of field tests and show that documentation and spare parts have been updated.

The minimal installation testing requirements for fiber optic transmission subsystem, Termination equipment sub-system and NMS are provided in respective Tables in this section.

#### 6.5.2.2 Link Commissioning Tests

The commissioning tests shall verify that communication can be performed over the fiber optic link under test. Delay measurement, Bit Error measurements & service channel performance monitoring shall be made on the fibre optic links to verify compliance with designed link performance.

For Ethernet interface: At a minimum the following test requirements shall be demonstrated as per RFC 2544:

a) Ping test
b) Throughput test
c) Latency test
d) Packet Loss

10% of the total links (Chosen by the Employer, generally to cover links from all configurations used) shall be tested for a duration of 12 Hours.

Rest of the links shall be tested for 1 Hour. In case a link does not meet the performance requirements during 1 hour, then the duration of the test shall be increased to 12 hours.

In case any link does not meet the performance requirements during 12 hour, then the cause of failure shall be investigated and the test shall be repeated after rectifying the defects.

This phase of testing shall be conducted by the Contractor and witnessed by the Employer. Field adjustments shall be made to meet established standard, however if the field adjustments fail to correct the defects the equipments may be returned to the Contractor for replacement at his own expense. In case any adjustments are required to be made during the interval of the test then the test shall be repeated.

### 6.5.2.3 Integrated Testing

Prior to commencement of integrated testing the overall system shall be configured as required to provide all the data and voice channel required to interconnect the various control centres and RTU. The integrated testing for a batch shall include end-to-end testing of back-bone network included in that batch. Integrated testing for last batch shall include testing of the entire back-bone. The intent of integrated testing is to demonstrate that the equipment is operational end to end under actual conditions, that all variances identified during factory and field installation and communications testing have been corrected, and that the communication equipment is compatible with other equipment at all locations. The Integrated System Test shall include all fibre optic transmission equipment, termination equipment, the network management subsystem and other components.

At a minimum the following tests shall be included in the integrated testing :

(1) Installation testing for NMS as per tables below
(2) Equipment configuration shall be checked to establish that it supports the channel routing.

(3) End to end testing of all individual voice circuits originating from PLCC, PABX or Phones and to establish proper interfacing with PLCC\PABX\Phones and to demonstrate proper operation of channels over wideband systems. Operation shall be checked in terms of quality of voice, call initiation and call termination processes.

(4) End-to-end testing of all individual Data Circuits originating from PLCC, RTU and SCADA Front Ends and to establish proper interfacing with PLCC\RTU\Front End and to demonstrate proper operation of channels over wideband systems. Operation shall be checked in terms of monitoring of BER/packet loss.

(5) Testing of NMS to demonstrate proper operation of all functions: Configuration Management, Performance Management, Fault, Management and Security management. All the standard features of the NMS shall be demonstrated for proper functioning.

(6) Demonstration of Protection switching and synchronization of equipment as per synchronization plan.

**Table 6-21**

**Fibre Optic Transmission system Installation Testing**

| Item: | Description: |
|---|---|
| **1.** | Physical Inspection for conformance to drawings, rack elevations and appearance of equipment and cabling |
| **2.** | Station power supply input and equipment power supply (DC-DC converter) output voltage measurements |
| **3.** | Terminal transceiver performance testing (Tx power, Tx spectrum, receive signal strength, connector losses etc.) |
| **4.** | Service channel performance |
| **5.** | Craftsperson interface, alarm and control functional performance |
| **6.** | Rack and local alarms: No alarms shall be present and all alarms shall be demonstrated to be functional |
| **7.** | Network management interface and supervision performance |
| **8.** | Correct configuration, level setting & adjustments and termination of Input/ output interfaces |
| **9.** | Proper establishment of Safety and signalling earthing system and resistance to ground to be checked. |
| **10.** | Simulation of failure conditions and failover of protected components. |

**Table 6-22**

**Termination Equipment Sub-system Installation Testing**

| Item: | Description: |
|---|---|
| **1.** | Physical Inspection for conformance to drawings, rack elevations and appearance of equipment and cabling |

**Table 6-21**

**Fibre Optic Transmission system Installation Testing**

| | |
|---|---|
| **2.** | Power supply/converter voltage measurements |
| **3.** | Muldem performance testing |
| **4.** | Craftsperson interface, alarm and control functional performance |
| **5.** | Rack and Local alarms |
| **6.** | Network management interface and supervision performance |
| **7.** | Channel performance |
| **8.** | Safety and signalling earthing system |
| **9.** | Simulation of failure conditions and failover of protected components. |

**Table 6-23**

**NMS Installation Testing**

| **Item:** | **Description:** |
|---|---|
| 1. | Physical inspection for conformance to drawings, rack elevations and appearance of equipment and cabling |
| 2. | Workstation hardware inventory, configuration and characteristics |
| 3. | Demonstration of proper operation of all hardware, including workstations peripherals |

**----------End of this Section----------**

# Section-07

# Training and Support Services

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# Section-7

# Training and Support Services

This section describes the requirements for Contractor-supplied training, support services, and maintenance of the FOTS, Terminations equipments sub-systems, Network Management System, DCPS & Battery. The intent of the training and support program is to ensure a smooth transfer of systems and technologies from the Contractor to the Employer/Owner, and to ensure that Employer/Owner staff are fully trained to operate, maintain and expand the integrated telecommunication network.

## 7.1 Training

The Contractor shall provide a comprehensive training program that prepares the Employer/Owner's personnel for on-site installation support, operation, and maintenance of the telecommunication network.

Training may be conducted by the Contractor, the Contractor's subcontractors, and/or original equipment manufacturers (OEMs). The training requirements of this Specification shall apply to all such courses.

Training courses shall be conducted by personnel who speak understandable English and who are experienced in instruction. All necessary training material shall be provided by the Contractor. The training charges quoted by the Contractor shall include training materials and all associated expenses. However, for all training courses in India or abroad, the travel (e.g., airfare) and per diem expenses of the participants will be borne by the respective Employer/Owner. For courses conducted abroad, however, the Contractor shall extend all necessary assistance for making appropriate lodging arrangement.

Hands-on training shall be with equipment identical to that being supplied to the Employer/Owner.

The schedule, location and detailed training contents shall be submitted by the Contractor to the Employer/Owner for approval.

### 7.1.1 System Design & Overview Training

This training shall provide a functional description of the telecommunication subsystems for both fibre optic transmission system and Termination equipment system and a discussion of the failover and alternate routing schemes inherent in the configuration. The training shall include an overview of the network configuration and indicate the functional responsibilities of all major subsystems including the network monitoring system hardware and software. The training shall highlight all significant methodologies or concepts utilized by the hardware and software to perform the required functions. High-level hardware configuration block diagrams and network/subnetwork block/flow diagrams shall be included to enhance the understanding of the overall capability incorporated into all network and sub network equipment.

The training shall be oriented to a user's point of view. The Employer/Owner users will include

managers, design & planning personnel, communication support staff and maintenance personnel. As part of the proposal, the Contractor shall identify the number of days deemed appropriate for this training.

In addition, the contractor shall also provide the training on the DCPS & Battery for the supplied system. The training shall cover aspects covering installation, testing & commissioning of DCPS & Battery. Proper emphasis of the training shall be for effective operation & maintenance of DCPS & Battery on routine & emergency basis by the Employer/Owner's personnel.

The overview training shall be customized for the specific functions, features, and equipment purchased by the Employer/Owner; it shall not be a general presentation of the Contractor' standard equipment repertoire. Personnel assigned by the Contractor to implement the Employer's system shall conduct this overview training. The Employer shall review and approve the contents of the overview training at least four (4) weeks prior to the course.

### 7.1.2 Supervision, Maintenance and Installation Crew Training at Site

The Installation, Supervision & Maintenance training course shall enable the trainees to effectively supervise the fibre optic cable installation work from an Employer perspective, particularly with respect to installation quality checks and safety procedures. The training shall cover FO cable handling techniques, stringing and installation, jointing & splicing, OTDR use and OTDR trace analysis, operation, preventive maintenance, troubleshooting procedures, corrective maintenance, and expansion procedures.

It shall also cover an appreciation of restorative procedures required after any likely cable failure such as cable breaks due to storms or falling trees, installation hardware failures or misalignments.

Installation crew training shall be predominantly hands-on training courses provided for a group of persons. The intent of this training is to enable Employer to undertake maintenance & restoration work in case of cable breaks or other such failures.

The Contractor shall submit for approval a detailed proposal for this training as per the agreed documentation schedule. The proposal shall include information such as proposed number of trainees, trainee profile, course duration, training facilities and methodology to be used etc. The training charges for this training course shall be separately identified in the Bid Price Schedules.

### 7.1.3 Fibre Optic cable Installation and Maintenance Training

There shall be installation & maintenance training for Fibre Optic cable & associated items.

The installation & maintenance trainings shall enable the Employer to be self-sufficient in preventive & restorative maintenance of the Fibre Optic cable & associated items purchased by the Employer. The training courses shall cover Fibre Optic cable & associated items installation, testing & commissioning, preventive maintenance, diagnostic tools and troubleshooting procedures, corrective maintenance for Fibre Optic cable. The courses shall provide theoretical background and extensive hands on experience.

### 7.1.4 Installation & Maintenance Training of Communication Equipment & DCPS

There shall be separate modules of the installation & maintenance training for the following systems:

(1) FO Transmission System Training
(2) Termination Equipment System Training
(3) DCPS & Battery System

The installation & maintenance trainings shall enable the Employer/Owner to be self-sufficient in preventive & restorative maintenance of the respective communications subsystems purchased by the Employer/Owner. The training courses shall cover equipment installation, testing & commissioning, operation, interfaces and cabling between equipment, preventive maintenance, diagnostic tools and troubleshooting procedures, corrective maintenance, and expansion procedures for all equipment. The courses shall provide theoretical background and extensive hands on experience.

Courses shall include equipment adjustments, board-level troubleshooting and repair and, where appropriate, component-level troubleshooting and repair. Course participants shall operate actual equipment and diagnose and repair simulated failures.

### 7.1.5 Network Management Training

The Network Management training shall familiarize the Employer/Owner's telecommunication personnel with the concepts and techniques for configuring, programming, maintaining, and troubleshooting the Contractor supplied NMS and its associated database. The training course shall provide a thorough understanding of the general design concepts, features, and user interface requirements for local and remote monitoring of the equipment, as well as procedures for restoring service after equipment and power failures.

The Network Management training course shall provide the course participants with hands-on experience using the actual system being supplied. Table 7-1 summarizes the minimal Network Management training requirements.

Training aids for each course shall include the Operator's User Manual for each type of equipment. Operator training that is a standard part of the maintenance training will be applicable.

**Table 7-1:**
**Network Management System Training**

| Item: | Description: |
|---|---|
| **1.** | Features of the software being supplied |
| **2.** | System generation and configuration procedures, including memory allocation, operating system parameterization, and buffer sizes |
| **3.** | Operating system concepts, including resource allocation, priority level processing, performance monitoring, diagnostic messages, and restoration procedures. |
| **4.** | Concepts and techniques for generating, modifying, and saving database, CRT displays, and reports |
| **5.** | Utilities, techniques, and equipment used for editing, debugging, testing, integrating, expanding and documenting new programs and subsequent implementation in software and/or firmware. |

### 7.1.6 Training Course Requirements

This section describes general requirements that apply to all training courses. The Contractor shall submit the training proposal along with the bid. The training content, schedule and location shall be finalised during project execution.

#### 7.1.6.1 Class Size

The Employer/Owner plans to send a number of participants to the training courses for a specified duration as described in Appendices.

#### 7.1.6.2 Training Schedule

The Contractor shall provide training in a timely manner that is appropriate to the overall project schedule. All training courses shall be available to the Employer/Owner for a minimum of five years after final acceptance of the communication system.

The training courses shall be scheduled so that an individual trainee could attend every course. The training shall be completed prior to the start of installation at site.

The Contractor shall take the above requirements into account in developing the preliminary training schedule. Contractor shall develop a final training schedule in consultation with the Employer/Owner after contract award.

#### 7.1.6.3 Manuals and Equipment

The Contractor, subcontractor, or OEM shall prepare training manuals and submit them to the Employer for review at least one month prior to the start of training. The training manuals shall be prepared specifically for use as training aids; reference manuals, maintenance manuals, and user's manuals may be used as supplementary training material. Principal documents used for

training shall be tailored to reflect all the Employer requirements specified.

Each course participant shall receive individual copies of training manuals and other pertinent material at least two weeks prior to the start of each course. The Employer/Owner shall retain the master and two additional copies of all training manuals and materials as reference documentation. A complete set of instructor's manuals and training aids shall also be provided.

Upon completion of each course, instructor's manuals, training manuals, and training aids shall become the property of the Employer. As part of the delivered system documentation and the final documentation, the Contractor shall supply the Employer with all changes and revisions to the training manuals and other training documentation. The Employer reserves the right to copy all training manuals and aids for use in the Employer-conducted training courses.

The Contractor shall furnish for use during training courses all special tools, equipment, training aids, and any other materials required to train course participants.

#### **7.1.6.4** Specialisation Certificates

The trainees shall undergo performance evaluation tests during the courses. The Contractor is required to provide certificates to individual trainees, providing the list of activities for which he/she has been trained.

## 7.2 Support Services

Throughout design, implementation, factory testing, and field installation and testing, the Contractor shall supply consulting assistance, as required by the Employer for site preparation, field installation, and other areas where technical support may be required.

The Contractor shall be responsible for minor facility renovation, and maintenance of the supplied system up to and including successful completion of the Site Acceptance Test.

After final acceptance of the communications equipment, the Contractor shall offer continuing technical support and spare parts for the communications equipment for the designed life of the equipment or 7 years after the declaration of withdrawal of equipment from production whichever is earlier. However the termination of production shall not occur prior to Operational Acceptance of the system by the Employer.

### 7.2.1 Technical Support

Consultation with Contractor's technical support personnel and trained field service personnel shall be readily available on a short-term/long-term basis to assist the Employer personnel in maintaining, expanding, and enhancing the telecommunication network upon expiration of the warranty period. The Contractor shall include in their offer(s), a proposal for ensuring continued technical support as stated above.

### 7.2.2 Contractor's Future Hardware/Software Changes

The Employer shall be informed of all alterations or improvements to the hardware supplied

under this Specification. The Employer shall be placed on the Contractor's mailing list to receive announcements of the discovery, documentation, and solution of hardware/software problems as well as other improvements that could be made to supply equipment. The service shall begin at the time of contract award, and shall continue for 10 years. The Contractor shall also include a subscription to the hardware subcontractors' change notification service from the time of contract award through the warranty period, with a Employer renewable option for extended periods.

## 7.3 Spare Parts and Test Equipment

The spare parts and test equipment shall be provided for each subsystem as described below.

### 7.3.1 Mandatory Spare Parts

Appendices provides the Mandatory Spare Parts Requirements described in **subsystem sets**. The mandatory spare parts table represents the minimum spares the Contractor shall be required to supply. The **subsystem set** of spare parts is defined to include all equipment modules, subunits and parts required to effect replacement, repair and restoration to full operational status of a defined unit of a subsystem (i.e. SDH equipment, Primary Mux, Drop/Insert, DACS etc.)

### 7.3.2 Recommended Spare Parts List

The bidder shall propose a comprehensive spare parts strategy. The intent of the spare parts strategy is to ensure a readiness against unforeseen cabling system breakdown; and to carry out replacement maintenance of susceptible or failed components. Consistent with the proposed spare parts strategy, the bidder shall provide a list of "Recommended Spare Parts", which may be required over and above the spares listed in Mandatory Spare parts list to support system availabilities specified in specifications during a one year period. This list of spares shall be called the "Recommended Spare Parts List".

The Recommended spare parts list shall not be considered for evaluation and may be included in the final scope of supply. The Bid shall include the following minimum information for the recommended spare parts:

a. Original manufacturer and part number
b. Name and Description
c. Either theoritical or empirical MTBF of the unit
d. Number of units in each set
e. Total number of sets to be provided per Employer/Owner

The unit as well as set prices shall be provided for each subsystem set item of the spare parts list in the appropriate Bid Price Schedule.

### 7.3.3 Test Equipment

Appendix-B provides mandatory test equipment requirements, to be provided. The parameters / features of the mandatory equipments are enumerated in Table 7.2 below:

| Table 7.2 | | |
|---|---|---|
| **S.No.** | **Test equipment** | **Parameter** |
| **A.** | **Test Equipments for OPGW cable** | |
| 1 | OTDR (Optical Time Domain Reflectometer) for 1310/1550 nm with laser source. | Equivalent to Anritsu MW9076B1 or better. |
| 2 | Optical Attenuators (variable 1310/1550nm). | Equivalent to JDSU OLA55 or better. |
| 3 | Optical Power meter (1310/1550nm) with Laser Source. | Equivalent to JDSU OLP55 or better |
| 4 | Optical Talk set. | Equivalent to JDSU OTS55 or better. |
| 5 | Optical Fibre Fusion Splicer incl. Fibre cleaver | Equivalent to Sumitomo T-39-SE or better. |
| 6 | Calibrated Fibre | |
| 7 | Connectorization kit | FIS–FI-0053-FC-INST or equivalent |
| 8 | Splice kit | FIS – FI-0053-FF or equivalent |
| 9 | Optical test accessory kit including all necessary connectors, adaptors, cables, terminations and other items required for testing | FIS – FI-0053-TS-ST or equivalent |
| **B.** | **Test Equipments for Communication Equipments** | |
| 1 | SDH Analyser* with Jitter and Wander Options | Equivalent to Acterna (JDSU) MTS6000 or better |
| 2 | Handheld 2Mbps BER Tester | Equivalent to Trend Communications model Tango E1 or better |
| 3 | Digital Multimeter | Equivalent to Fluke287 or better |
| 4 | Ethernet Tester (with dual port, 10/100 ports Mbps Ethernet option, layer-1 & layer-2 functionality ) | Equivalent to Trend Unipro GbE or better |

Note: * The testing capacity of SDH analyser shall be provided according to offered SDH equipment

In case the offered make/model of test equipment has multiple options for the parameters, the option of higher range shall be acceptable. The supplied test equipment shall be suitable for use in the high EMI/EMC environment. The Contractor shall submit performance certificate for offered test equipment from at least one customer. The Contractor shall offer only reputed make test equipment such as Acterna (JDSU)/Trend/Anritsu/ Fluke/Agilent etc.

The Contractor shall provide in their bid, additionally recommended test equipment list necessary to support specified system outage requirement. These lists shall include all relevant technical descriptions and recommended minimum quantities and maintenance concept. The recommended test equipment along with the test equipment listed in Appendix may be included in the final

scope of supply and the price thereof shall not be considered for evaluation.

## 7.4 System Maintenance

As per DoT guidelines, operation and maintenance of the network shall be entirely by Indian engineers and dependence on foreign engineers shall be minimal within a period of two years from the date of LoA. The contractor shall be responsible to maintain the confidentiality of the Employer's System Information that Employer shares with the contractor for maintenance period.

### 7.4.1 Warranty Period

The one year period commencing immediately after the operational acceptance is called the Warranty Period/Defect liability Period. In addition to the responsibilities covered under Vol-I Condition of Contracts during Defect Liability Period, the Contractor shall also be responsible for maintenance of the Fibre Optic Transmission System, Termination Equipment, NMS, DCPS & Battery etc. supplied under this Package. The specification for the maintenance of the system after Operational Acceptance is enclosed at Annexure-I.

### 7.4.2 Contractor's Maintenance Responsibility

The Contractor shall be responsible for carrying out "Comprehensive Maintenance" of the Communication System (excluding FO cabling) for a period of six years excluding warranty period ensuring the successful operation of the system. The Contractor shall be responsible for achieving the system availability and the response time mentioned in technical specifications. The bidder shall quote the Annual Maintenance Charges for six years after Warranty Period which shall be considered in the bid evaluation. Bidder shall submit the detailed procedure for achieving above in the bid. The specification for the maintenance of the system is enclosed at Annexure-I. Upon expiry of the six years AMC period Employer may, at its discretion, extend this Maintenance for two (2) additional years at the same terms and conditions.

## 7.5 Miscellaneous Supplies

The Contractor shall provide all required consumable and non-consumable supplies necessary to support all installation and test activities through final operational acceptance. However, if there are any problems in the SAT and additional consumables are required, the same shall also be supplied by the Contractor free of cost.

## Technical Specifications for Maintenance after operational acceptance during maintenance period

### A -1.0 GENERAL

The Contractor shall be responsible for comprehensive maintenance of the all the communication equipment, DCPS & Battery system supplied & installed under this Contract. The maintenance contract shall commence after completion of the project i.e. after Operational Acceptance. Communication network & BOQ is given in Appendices. There may be some variation during detailed engineering. Contractor shall meet system availability of 99.9% for fibre optic system . Contractor will have to make their own assessment of the network and deploy manpower accordingly. However, it is to be ensured that specified manpower of requisite qualification are deployed. Availability calculation shall be done separately for Fibre Optic System.

Contractor's maintenance engineer/service engineer shall have minimum qualification of graduate in Computer or IT or Electronics & Telecommunication with minimum one year experience or Diploma with three years maintenance/testing & commissioning experience on the equipment proposed to be supplied & installed. The Degree/Diploma must be recognised Indian professional qualification. This staff shall be supported by head office technical staff for restorative problem or other assistance as may be required. Maintenance engineer shall have technical background and trained in first & second level maintenance on the supplied communication system, DCPS & Battery and NMS system of their own without technical assistance from Head Office.

Contractor will arrange for adequate transportation for their staff as per the work demand. Contractor's staff (at all locations) should be equipped with necessary tool kits, mobile phones, vehicle etc.

The Maintenance of the system supplied & installed by the Contractor shall be comprehensive and all the spares required during maintenance period shall be provided by the Contractor at no additional to Employer.

### A - 1.1 RESOURCE DEPLOYMENT

In order to cover the entire network, it is imperative that Contractor's maintenance engineers are strategically located so as to reach the site within shortest possible time frame. Thus a minimum of three (3) engineers will be deployed at three (3) locations (one person each at Shillong, Badarpur, Mariyani, this however, does not relieve contractor from its obligation to maintain required system availability of 99.9% for Fibre Optic System. Accordingly, Contractor shall asses the actual manpower requirement and place them suitably at other locations, if required. The exact location for deploying engineer shall be finalised during detailed engineering. The central control and monitoring of communication system will be performed from Shillong by means of the centralized NMS. The other locations will work under the control /instruction of the co-ordinator located in Shillong.

## A 1.2 MONITORING

Network will be monitored by POWERGRID through centralized NMS to be located at Shillong. Network Monitoring Team (NMT), whenever, notices any fault/abnormality in the system shall notify to the Contractor's maintenance Co-ordinator at Shillong, over phone with an event no. An event report shall be generated by POWERGRID as per the enclosed formats. On issuance of Event report (may be recorded over phone in case of non-availability of Contractor's representative at Shillong) by NMT, corrective action/s shall be carried out by Contractor's maintenance personnel for rectification. Contractor's representative must report within four (4) hours at locations where Contractor's engineers are stationed and within reasonable time at all other location which shall in no case exceed more than 12 hours (including travel time). Time mentioned here is irrespective of normal working hours or holidays. The NMT shall co-ordinate and control any site visits to ensure that communication network is operating with a minimum of disruption during these visits. The NMT will inform the relevant POWERGRID/constituent to facilitate the access to the site/equipment where fault is suspected.

The main responsibilities of the POWERGRID's Network Monitoring Team are:

a) Communication Network monitoring through Network Management System (NMS)
b) Detect faults, prioritizing them and notifying to the Contractor for immediate corrective actions.
c) Follow up on corrective actions to verify that the agreed time frames are met.
d) Record all faults in the fault record sheet and summary of action taken for fault rectifications.
e) Co-ordinate all planned / breakdown site visits to minimize disturbance of service.
f) Update status information of operated network to users communication network.

## A 1.3 MAINTENANCE

Maintenance activities are either Event Based (Fault/breakdown maintenance,) or planned site visits (Semi annual site visit, testing of channel/s, augmentation and modification in the network if end equipment for data/speech does not communicate with corresponding equipment as and when required. Planned visits shall mainly carried out during working days.

Event based work is to be carried out round the clock seven days a week, A start status shall be jointly filled by POWERGRID & Contractors representative at 10.00 Hrs of commencement date of maintenance contract.

Planned site visits shall be carried out twice in a year (semi-annually) at all the sites in the network or time to time if speech/data is affected at a particular site. Thus, in a year, not less than two planned site visits to all locations will be undertaken.

Contractor will maintain record of events during the maintenance services ; simultaneously POWERGRID/Constituent shall also record the events in the LOG BOOK available in the NMS control room.

The tasks during the planned site visits for the system include but are not limited to following:

- Visual inspection of equipment
- Alarm measurement verification
- Status report of site
- Updating of log records
- Cleaning the equipment
- Tightening of connectors
- Sealing of cabinets to arrest entry of rodents etc.
- Measurement of earth resistance

Work to be taken up during semi-annual site visits is given in enclosed Format.

Fault/Breakdown maintenance is a process of fault correction / trouble shooting/interfacing with other contractor (for data & Speech connectivity of existing RTUs & EPABXs etc.) as per the fault reported by NMT. Contractor will maintain a log of activities carried out at all locations and necessary History will include site name, visit date, actions taken and site condition. Detailed report in this respect shall be submitted by the contractor in the monthly meeting.

The representatives of POWERGRID/ Constituents will associate in trouble shooting, change of unit as per programme notified/intimated by the contractor however, due to any reason if POWERGRID/ Constituents cannot depute their representative, contractor will proceed for the work so as to attend the breakdown/testing as per their programme.

The scope of corrective maintenance is as follows:

- Troubleshooting on a network element and its interfaces as and when required and directed by NMT, engineer/coordinator of POWERGRID.
- Diagnostics on interfaces to locate problems in network elements. If required, the contractor shall depute maintenance engineer for joint inspection with other vendors for pin-pointing the fault.
- Identification of the faulty hardware unit, replacing it.
- Performance of function verification in co-ordination with the NMT operators
- Handing over of faulty unit to constituent/POWERGRID at site or RLDC.

**MAINTENANCE OF DC POWER SUPPLY SYSTEM**

(DCPS includes charger, Batteries, DCDB and other associated cables/connectors, Meters, relays,switches, surge protection devices etc.)

The Contractor shall carry out both preventive and break down maintenance of the supplied DCPS & Battery System.

**Preventive Maintenance (PM)**

This consists of necessary measures to maintain the equipment in the proper operating condition. Preventive maintenance includes functional checking, cleaning and necessary repair/replacement/adjustments etc. It will be carried out quarterly at mutually agreed dates.

**Break Down Maintenance**

Break Down Maintenance is to be carried out in the event of malfunctioning of DCPS equipment, which blocks the normal operation of the DCPS. Break down maintenance includes faultfinding, repair or replacement of defective parts and functional checking.

Immediately on noticing the fault, the fault will be reported by the constituent/POWERGRID on phone to the contractor. The fault reporting time on phone shall be taken as reference time for the purpose of RT and TAT.

(RT is Response Time when contractor's person report at site after reporting of fault in system. TAT is Turn-Around-Time when system is brought back in service after necessary rectification/replacement works.

## A 1.4 HARDWARE SERVICES

In case any failure or malfunction is discovered, the maintenance team shall identify the problem, organise to promptly attend the fault, replace the faulty equipment/card/module or any other hardware component with a spare unit and ship the faulty unit to specified location. Each faulty unit shall be accompanied with correctly filled-out Event Report. Contractor shall ensure maximum utilisation of the channel capacity, hence healthy channel/s will be put in use and hardwired to respective DDF/MDF point, in coordination with POWERGRID, without disturbing end user (PABX,PLCC, RTU ) connection so that outright replacement of card is avoided. Card shall be replaced when all the healthy channels are faulty. Necessary modification (temporary) in drawing/s in site copy and at CPCC/NMS location/SLDC's will have to be done without changing in original document.

The Contractor shall be responsible for providing all the spares (cards/modules/accessories etc.) for supplied & installed equipment such as SDH, MUX, DCPS, Battery, NMS etc. The spares shall be provided/arranged by the contractor at no extra cost to Employer**.** For early restoration during the emergency condition, if spares are made available by Employer, the same shall have to be replenished by the Contractor within thirty (30) days.

Contractor's hardware services shall also cover support for the NMS hardware & Software supplied to POWERGRID as part of the Contract. Contractor shall be responsible for providing spares for the supplied NMS system, if required, during maintenance period at no additional cost to the Employer. The Contractor shall provide support within four (4) hours of fault reporting at Shillong site and the next day for all other outstation sites after logging in of the faults.

Contractor will carry out the following tasks for hardware services:

a) Handover the faulty unit/s to Employer
b) Replace faulty units from their own spares stock.
c) Send faulty units to Original equipment supplier's representative in India on Employer behalf with the correctly completed Failure Report with site information and symptoms of failure.
d) Test the repaired unit for their healthiness after the same is rectified by the original manufacturer.

## A 1.5 MAINTENANCE SERVICES SUMMARY

The Maintenance Services are summarised below:

| **ON SITE SUPPORT / MAINTENANCE** | |
|---|---|
| Scope | Three Engineers + One Co-ordinator |
| Availability | On all working days of week except on Sundays & holidays during office hours. After office hours / Holidays, duty phone to be contacted (with co-ordinator) |
| Task | Troubleshooting & Fault rectification |
| | |
| **MAINTENANCE FAULT/BREAKDOWN** | |
| Equipment Scope | As per BoQ enclosed in Appendices |
| Scope | Rectification /Corrective maintenance |
| Availability | On call basis as mentioned above in TS |
| | |
| **PLANNED SITE VISIT** | |
| Equipment Scope | As per BoQ enclosed in Appendices |
| Scope | Visual inspection of equipment, alarms measurement verifications, status report of site, updating of log record, cleaning the equipment, modification & augmentation |
| Availability | Semi-annual / planned visits |

## A 1.6 OUTAGE TIME DEFINITION:

An outage time refers to period in which loss of communication is detected on any part of the telecommunication network / equipment and continues until the fault is cleared by taking into account conditions listed below.

a) Time of unavailability excludes running with faulty equipment on specific instruction from POWERGRID/Constituent (not affecting communication or monitoring of other units other than faulty unit).

b) The time of unavailability excludes the transportation time to a faulty site average of twelve (12) hours and time to get authorization for access to the telecommunication room and to the equipment.

c) An event would not be considered as failure when the system features allow to continue the data/voice transmission utilizing redundancies available in the subsystem/equipment.

d) In case of failure of any E1, no consequential lower level channel failure shall be accounted for.

e) In case a loss of communication is detected in system of third party (PLCC/PABX equipment, RTU/SCADA, existing SDH/PDH equipment procured under separate contract) and no corresponding alarm is detected in NMS the event will be jointly studied with the parties and plan/schedule of fault finding will be made. However, under such conditions of fault attribution to the third party, it would be contractor's responsibility to logically establish such attribution.

f) If it is needed to identify the fault, it is allowed to disconnect/loop circuits for trouble shootings. This testing time shall not be counted in the outage time calculations. However, interruption time for healthy channel should not exceed 10 minutes. Proper planning and coordination with all concerned may be required while carrying out this activity so as to minimize outage time.

g) Outage due to force majeure conditions ( Not attending fault due to war, curfew, earthquake at the location of fault, serious accident during traveling for attending fault) or outage due to failure in power system equipment other than supplied by the Contractor (or AC/DC).

h) Outages which are not attributable to equipment faults such as fault in fibre optic cable will not be considered for calculation in system availability.

## A 1.7 DOCUMENTATION DURING MAINTENANCE PERIOD

Events shall be recorded by using of event form. The forms shall be filled in duly dated, timed and signed by representatives of both the parties. Absence of one or the other party's representative shall not render the record invalid but assumes only that such representative signs the record at his earliest convenience.

The initial condition of the system shall be recorded on the start status form to constitute or reference for later events. All the events recorded in the start status form shall have to be rectified within 15 days. Faults not attended within 15 days will be considered as outage. Any and all events such as incoming and existing alarms, fault occurrence, action taken for remedies etc. shall be recorded in the event report forms. If a unit is replaced or repaired both the new and the replaced or repaired unit is to be recorded in the event report form. Contractor shall submit the detailed report for fault occurrence after the cards/equipment is rectified at the works of supplier.

## A 1.8 CALCULATION OF NETWORK AVAILABILITY

The system availability shall be calculated as per following formula during the Maintenance period.

**Availability Calculation Formula**.

$$\text{System Availability} = \frac{T_t * Ch_t - \sum Ch_n * T_n}{T_t * Ch_t} \times 100\% \quad (n=1 \text{ to } Ch_t)$$

Where
SA = System Availability (%)
$T_t$= Total test time (24* days in a month)
$Ch_t$ = Total number of channel
$Ch_n$ = Number of channels affected by event En
Tn = Outage time of event En

The NMS availability for both PDH/SDH shall be calculated as follows:

$$\text{Availability of NMS(Av).} = \frac{T_t * NE_t - \sum NE_n * T_n}{T_t * NE_t} \times 100\%$$

Where
Av = NMS Availability(%)
Tt = Total test time(24 * days in a month)
$NE_t$ = Total number of network Element
$NE_n$ = Number of NE affected by an event
Tn = Outage time of NE

## A 1.9 AVAILABILITY REQUIREMENT

The availability of wideband communication equipment shall be measured in categories as below:

a) Channel (Voice, Asynchronous & Synchronous data circuits and management data channels)
b) E-1 /Ethernet channels
c) Availability of NMS system

The availability requirement for type of channels for wideband communication equipment and NMS systems shall be 99.9%.
However not withstanding he commutation of availability of the communication system as specified above, the prompt restortion of the faulty equipment/part of the network is also of equal importance and any delay in restoration of the faulty system shall be goverened as per terms & condition of the contract.

## A 1.10 SCOPE OF WORK DURING MAINTENANCE PERIOD

| Sl.no. | Description | Detailed Scope |
|---|---|---|
| *1* | ***Overall*** | Infrastructure includes the building, air conditioners, |

| | | |
|---|---|---|
| | ***Infrastructure*** | AC/DC system, UPS, cable trenches, Earthing etc provided by POWERGRID. They will be maintained by POWERGRID |
| **1.1** | ***Equipment site*** | |
| 1.1.1 | General conditions | General checking during semi annual / troubleshooting site visits and advise |
| 1.1.2 | Cleanliness of the room | General checking during semi annual / troubleshooting site visits and advise. |
| 1.1.3 | Earthing interconnections | Checking, connector cleaning, redoing the connection during semi annual / troubleshooting site visits (limited to the earthing of equipment under scope of maintenance)and as required specifically. Earthing interconnection will be checked upto earthing star point). Earthing interconnection shall also be checked and corrected during troubleshooting site visits if it is considered the probable cause of fault. Measurement of earth resistance during semi-annual site visit |
| 1.1.4 | Air conditioning | General checking during semi annual / troubleshooting site visits and advise |
| 1.1.5 | Cable route | General checking during semi annual / troubleshooting site visits and advise |
| 1.1.6 | EMI issues | Contractor shall study in special case of repeated faults if the probable cause is earthing interconnection at the station or possibility of spurious signals through various cable connections to the wideband equipment and advise. |
| 1.2 | DC system | Site checking (normal output, battery condition, earthing interconnection) as per approved/agreed format during semi annual site visits and advise. It shall also be checked during troubleshooting site visits if it is considered the probable cause of fault. |
| 1.3 | UPS | Checking of output values, earthing interconnection at the NMS sites during semi annual site visits and advise. It shall also be checked during troubleshooting site visits if it is considered the probable cause of fault. |
| 1.4 | Interfacing with others | Checking interfacing with other equipment and take corrective actions on its MDFs if required. The scope will be limited to the MDFs where the cables of wideband communication system have been terminated. Report and advise on others' if it is the probable cause of fault. |

| | | |
|---|---|---|
| 1.5 | Indoor cabling | Checking terminations, re-kroning, if necessary, during semi-annual/troubleshooting site visits. It shall also be checked during troubleshooting site visits if it is the probable cause of faults. |
| 1.6 | Out-door cabling | Checking terminations, re-kroning, if necessary, during semi-annual/troubleshooting site visits. It shall also be checked during troubleshooting site visits if it is the probable cause of faults. |
| 1.8 | Fibre Optic Cable | Checking with OTDR and advice. Rectification if fault is found to be in the approach cable/patch cord etc. up to DDF. |
| ***2*** | ***Main Equipment*** | |
| 2.1 | PDH MUX & Digital Cross Connect | Faulty equipment to be replaced at site as per conditions of Maintenance Plan. |
| 2.2 | Fibre Optic terminal SDH | Faulty equipment to be replaced at site as per conditions of Maintenance Plan. |
| 2.3 | GPS Clock | Faulty equipment to be replaced at site as per conditions of Maintenance Plan. Contractor shall be responsible for providing hardware , if required, during maintenance without any additional cost implication to Employer. |
| ***2.4*** | ***NMS of SDH*** | |
| 2.4.1 | Computer hardware and Routers | Faulty equipment to be replaced at site as per conditions of Maintenance Plan. Comprehensive maintenance with hardware suppliers to be tied up by the Contractor. Contractor shall be responsible for providing all hardware & software required during maintenance without any additional cost implication to Employer. |
| 2.4.2 | Alarm handling, Backups etc. - software part | Alarm deletions, Backups as per maintenance plan. Consumables to be provided by Employer. Software corruption to be corrected as per actual requirement. |
| ***2.5*** | ***NMS of PDH(Mux, D/I & DACS) System*** | |
| 2.5.1 | Computer hardware | Faulty equipment to be replaced at site as per conditions of Maintenance Plan. Comprehensive maintenance with hardware supplier to be tied up by the Contractor. Contractor shall be responsible for providing all hardware & software required during maintenance without any additional cost implication to Employer |

| | | |
|---|---|---|
| 2.5.2 | Alarm handling Backups etc. software part | Alarm deletions, Backups as per agreed back up plan. Consumables to be provided by Employer. Software corruption to be corrected as per actual requirement. |
| 2.5.3 | Monitoring and general operation of communication link | Regular monitoring of the communication link operations through NMS in association with the Employer's staff. Investigations for abnormal behaviour and take corrective actions. |
| 2.5.4 | Provisioning/ Re-provisioning of channels | As per requirement. |
| ***3*** | ***Contractor's set-up*** | Generally in consonance with the set-up mentioned in the maintenance plan. |

**4 MAINTENANCE OF DC POWER SUPPLY SYSTEM**
**(DCPS includes charger, Batteries, DCDB and other associated cables/connectors, Meters, relays, switches, surge protection devices etc.)**

**Details of Job to be carried out during Preventive Maintenance**

1 Physical inspection of DCPS at all specified locations
2 Cleaning of System
3 Tightening of all the power and control connections including checking the input power cable terminations at both ends.
4 Checking of DC Voltage
5 Checking for AC Voltage L-L, L-N
6 Checking AC Current
7 Checking for ripple Voltage
8 Functional checking Of DC System For Normal Operation including battery charging
9 Checking for Normal operation of each Module
10 Checking of earthing of the system by measurement of earth to neutral potential.
11 Checking of charging condition of the batteries
12 Checking of the physical conditions of the batteries
13 Checking of each battery voltage during quarterly visits & battery impedance/resistance measurement twice during the contract during 2nd & 4th quarterly visit.
13 Three discharge tests per year at normal load for three hours during 1st, 2nd and 4th quarterly visit.
14 Checking of present load on charger.
15. Matching of DCPS parameters with SCADA system
16. Proper guidance to the operation staff for satisfactory working of the equipment and its proper upkeep.
17. Checking of battery terminals for corrosion and cleaning thereof, torqueing and greasing.

| |
|---|
| 18. C-3 discharge test on batteries once a year during 3rd quarterly visit.<br><br>Above observations shall be recorded as per enclosed format and duly signed at site by constituent/POWERGRID Engineer. |
| **Details of Job to be carried Break Down Maintenance**<br><br>1 Repair and replacement of Faulty Module<br>2 Repairing and replacement of faulty components in the system<br>3 Analysis report of the fault<br>4 Plan for preventive measure to arrest recurrence of such faults. |

## A 4.0 PANELTY FOR DEFAULT IN SERVICES

(a) Contractor will maintain an adequate level of qualified staff for carrying out this maintenance contract, failing which Rs 50,000/- per month will be deducted by Employer from the amount due to contractor under this contract. In addition 5% of the total payable amount shall be deducted for every fall of 1% or part thereof in the specified availability.

(b) In addition to above, a penalty of Rs 1000/- per day shall be imposed for not attending the fault in specified period for all non-communication equipment. For non-communication equipment maximum allowable restoration time shall be 48 Hrs.

(c) Employer shall have the right to terminate the contract after giving notice of two month if the availability of the system is not attained as per specification consecutively for two months.

## A 5.0 CO-ORDINATION REQUIREMENTS

### A 5.1 MEETING PRACTICE

Regular meeting between POWERGRID and the Contractor is vital for communication and information flow between these two organisations. The purpose of the meeting is to tackle the essential issues concerning the services and network performance. The suggested schedule for meeting is once in every month. The meeting agenda shall be decided between POWERGRID and Contractor and could for example consist of the following issues:

- Services and network performance according to the report during last month
- Review of emergency situation
- Status of spare
- Action plan
- Next Meeting
- Alarms/events unattended till the date of meeting

The following participants should be present in this meeting:

- Co-ordinator (Contractor)
- Members of the Contractor team as needed
- Co-ordinator POWERGRID/Constituents representative
- Operation and maintenance staff as designated to attend (POWERGRID)

## A 5.2 EMERGENCY MEETING

Whenever a major outage occurs in any part of the network, an emergency meeting may be called if desired by POWERGRID. In the meeting, the outage will be discussed in the context of cause, correction and prevention**.**

## A 5.3 REPORTING PROCEDURE

The purpose of report is to summarize the activities performed during the reporting period. The report provides the information on the performance of the services and describes the current status of the network. The report is a monthly report from Contractor to POWERGRID which shows the trends in the network and services provided by the Contractor. By analysing the report data, management and expert of POWERGRID and contractor are able to focus attention on the areas where further improvement is needed.

Emergency Reports: Contractor reports to POWERGRID every time the emergencies call up and call out service is invoked. In these cases, on termination of the emergency all details of the fault and clearance information are submitted within five working days.

## A 5.4 INTERFACE BETWEEN POWERGRID AND CONTRACTOR

### Contractor Interfaces

Contractor shall submit detail of personnel deployed in the enclosed format through which all problems identified by POWERGRID are to be reported to contractor via duty phone

| Description | Shillong | Badarpur | Mariyani |
|---|---|---|---|
| Name | | | |
| Telephone | | | |
| Fax | | | |
| Email | | | |

Co-ordinator :

Telephone no : Mobile no:

FAX No : E-mail address:

(Details to be provided later)

**Contacts in POWERGRID**

| Name | Responsibility | Phone number (Residence) (mobile) | Phone number office | Fax number, E-mail address |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |

**Form-I**

## EVENT REPORT FORM

Event Report No _____ Date:_____

Station:_____ Constituent:_____

Affected Path:

_____ _____

Fault Description: _____
_____

A) Event start time (as per NMS) date _____ time_____

B) Reporting time by NMT date _____ time_____

**REPORT**

i) Failure within contractor system
Yes ____ No _____ ( If No then date _____ time_____)

ii) Entrance to site and room for rectification date _____ time_____

iii) Rectification start time by Contractor date _____ time_____

iv) Fault fixed date _____ time_____

**Total Outage time** _____

Comments:
_____
_____
_____
_____

Faulty unit Sl. No:_____

New Unit Sl. No.: _____

Date:

POWERGRID/CONSTITUENT _____ Contractor_____

**Form-II**

# START STATUS FORM

Page: (1)
Report no:

**Start:** Date :_____ **Time :** 10.00 Hrs:

| | **Station** | **Description** |
|---|---|---|
| 1 | _____ | _____ |
| 2 | _____ | _____ |
| 3 | _____ | _____ |
| 4 | _____ | _____ |
| 5 | _____ | _____ |
| 6 | _____ | _____ |
| 7 | _____ | _____ |
| 8 | _____ | _____ |
| 9 | _____ | _____ |
| 10 | _____ | _____ |

Special test conditions or action:

Attachments:

Initials:
POWERGRID _____ Contractor _____

**Form-III**

# FORMAT TO BE FILLED DURING SEMI ANNUAL SITE VISIT

1. **SITE INFORMATION**:

Site name :----------

Address :----------

Contact Person :----------

Telephone & Fax :----------

**2. GENERAL CLEANLINESS**

Communication room air conditioner

- Is air conditioner on? Yes/No
- Are filters clean? Yes/No
- Is air conditioner cooling O.K? OK/NOT OK
- Action Required by POWEGRID/Constituent----------

---

Communication room cleanliness

- Check if communication room is in good condition (Over all)

---

- Check if regular cleaning of telecom room done.

---

- Check if room is manned.

---

- Check if AC/DC sully has been tapped for other uses.

---

- Is the room having any damp wall.

---

- Action required by POWERGRID.

---

Contractor's representative

POWERGRID/CONSTITUENTS's representative

**Form-III contd/-**

**EQUIPMENT RACK CLEANLINESS:**

- Check if cabinets are closed and key available with room in charge.

  Key available  Not Available  Cabinet Closed  Open

- Clean the equipment with vacuum cleaner.  Cleaned

Actions required by POWERGRID/Constituent:_____

Action required by Contractor:_____

**3.0 TEMPERATURE MEASUREMENT**:

Room temperature

- Check the room temperature (25$^{o}$C is recommended) _____
- Temperature very near equipment cabinet _____
- Temperature inside the telecom equipment rack _____

Action Required by POWERGRID/Constituents :_____

**4.0 POWER SUPPLY MEASUREMENT**

- Input DC Voltage at MCB _____
- Input DC Voltage at Cabinet TB _____
- AC Voltage at the time of station visit (Primary source): _____
- Availability of AC Supply in 24 hours _____
- Charger Voltage _____
- Battery Voltage (Charger AC Supply off) _____

Actions required by POWERGRID/CONSTITUENT _____

_____

**Contractor's representative**

**POWERGRID/CONSTITUENTS's representative**

**Form-III contd/-**

Action required by Contractor _____

## 6.0 MULTIPLEXER & SDH EQUIPMENT ALARM CHECK

Visual check for the alarm on Mux & SDH equipment, in case of any alarm present further investigation and corrective action**.**

**Healthiness of spare Fibre** Fibre no:
Colour :

From :

To :

Condition :

Equipment used :

Action required by Contractor:_____

## 7.0 CABLE CHECK

- Check the cable terminations at all MDFs visually. Recrone if any loose wires.
- Check cable route for any abnormality.
- Are cable trenches covered properly?

## 8.0 ANTENNA, ANTENNE PIPE SUPPORT, CABLE, TOWER

- Check base of tower. It should be clean from plant, grass, and waste material.
- Tower antenna should be free from honey bees, bird nests etc

**Contractor's representative** **POWERGRID/CONSTITUENTS's representative**

- Visual check of antenna for any damage & proper dealing at connector point.
- Visual check for cable and connectors.

## 9.0 DOCUMENTS AND TEST INSTRUMENTS

- Check the documents at site. Available Not available

**Form-III contd/-**

- Check the availability of test instrument/tool kit at site.(Multimeter,Screw driver,plier etc.) _____available

## 10.0 EARTHING CHECK

- All the cables are connected properly with the ground point.
- Clean the end points if required while removing the earth cable first put temporary earth cable. After correction place the original cable and remove loop cable.
- Clean star point with sand paper and put petroleum jelly.

- Measurement of earth resistance: _____Ω

**Contractor's representative** **POWERGRID/CONSTITUENTS's representative**

**Form -IV**

Format

**DC POWER SUPPLY EQUIPMENT MAINTENANCE FORMAT TO BE FILLED AT SITE**

**SITE INFORMATION**

**SITE NAME :** _____

**ADDRESS :** _____

---

_ ---

**TELEPHONE AND FAX NO** ----------

| | DESCRIPTION | VALUE,IF ANY | REMARKS |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| 1 | Cleaning done | | |
| 2 | Power connections checked for tightening & over heating | | |
| 3 | Control Connections are all tight | | |
| 4 | All indications/meters/display on the panel are working | | |
| 5 | Input frequency | | |
| 6 | Rectifier LEDs | | |
| 7 | Normal Operation on each module | | |
| 8 | Float voltage | | |
| 9 | Checking for ripple Voltage | | |
| 10 | Checking for AC Voltage L-L, L-N | | |
| a | R - Y | | |
| b | Y - B | | |
| c | R - B | | |
| 11 | Checking AC Current | | |
| 12 | Checking of DC Voltage | | |
| 13 | Checking of earthing | | |
| 14 | Battery voltage/resistance measurement done & enclosed | | |
| 15 | Load test done on batteries as enclosed | | |
| 16 | Check functioning of hooter/Buzzer (Alarm Annunciation) | | |
| 17 | Parameters checked in SCADA system | | |
| 18 | Proper guidance given for normal day to day operation. | | |

Suggessions from Contractor :

Remarks from Customer :

**CONSTITUENT/POWERGRID representative**

**Form-V**

**CONTRACT NO./DATE :**

**DESCRIPTION OF JOB :**

**CONTRACTOR :**

## BIO-DATA OF CONTRACTOR'S EMPLOYEES

**NAME :**

**AGE :**

**TRADE :**

**RESIDENTIAL ADDRESS :**

**TEMPORARY :**

**PERMANENT :**

**LANGUAGES KNOWN :**

**SPEAK :**

**READ :**

**WRITE :**

**QUALIFICATION :**

**TRAINING IN SAFETY / HEALTH / ENVIRONMENT :**

**QUALITY/TRADE :**

**JOB EXPERIENCE :**

PHOTO

**DATE:** **SIGNATURE:**

**----------End of this Section----------**

# Section-08

# Documentation and Deliverables

## Index

8.1 System Functional Description Document ---------- 2

8.2 System Documentation ---------- 2

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8.6 Drawing and Document Approval Procedure---------- 3

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# Section-08

# Documentation and Deliverables

This section describes the documentation requirements and provides a list of deliverable that the telecommunication system Contractor shall provide to the Employer. Complete documentation necessary for the operation and maintenance of the communication system is required. All the documentation shall be provided in hard copy and also on CD-ROMs in full compliance with the specification. Conditions pertaining to Document Review and Approval Rights and Document Submission Scheduling are specified in this specification. All documents shall be supplied in English.

As detailed in subsequent sections the documentation shall include the following:

(a) Detailed list of the deliverables
(b) Description of the products
(c) Technical particulars
(d) Installation manuals
(e) Maintenance manuals
(f) Quality assurance manuals, Manufacturing Quality Plan (MQP) & Field Quality Plan (FQP)
(g) Tests (type test, production, FAT, SAT) documentation

## 8.1 System Functional Description Document

The document shall include an overview of the system configuration. This document shall be designed to serve as a complete introduction to the supplied system and to the more specific documents that are defined in technical specifications. The document shall be oriented to the Employer user's point of view and be subject to the Employer's review and approval. Users will include POWERGRID operating personnel communication support staff and maintenance personnel.

## 8.2 System Documentation

A detailed documentation plan and document submission schedule shall be prepared and submitted for approval. The guidelines specified in table 8-1 and 8-2 shall be followed.

## 8.3 Supplementary Documentation

If during the training courses or while performing maintenance on such equipment during the warranty period, the Employer determines that additional information is required to perform the maintenance function, the Contractor and/or its subcontractors shall provide the specific supplemental information necessary to perform the maintenance function. This information shall be documented in a form suitable for incorporation into the appropriate maintenance document.

## 8.4 Test Documentation

The Contractor shall provide documentation for all factory and field tests.

The test documentation shall include the following:

(a) Test Procedure Document
(b) Type test documents
(c) Factory Acceptance Test Documents
(d) Site Acceptance Test Documents

## 8.5 Drawings

All drawings submitted by the Contractor including those submitted at the time of bid shall be in sufficient detail to indicate the type, size, arrangement, dimensions, material description, Bill of Materials, weight of each component, break-up for packing and shipment, shipping arrangement required, the dimensions required for installation and any other information specifically requested in the Specifications.

Each drawing submitted by the Contractor shall be clearly marked with the Employer name, the unit designation, the specification title, the specification number and the name of the Project. All titles, notes, markings and writings on the drawing shall be in English. All the dimensions should be to the scale and in metric units. The drawing revision level/ issue no, issue date shall be marked on each drawing and the drawing shall carry issue history information and appropriate signatures (eg: originator, checker and approving authority).

## 8.6 Drawing and Document Approval Procedure

The drawings/documents submitted by the Contractor shall be reviewed by the Employer as far as practicable with in stipulated duration and shall be modified by the Contractor if any modifications and/or corrections are required by the Employer in compliance with the Specifications. The Contractor shall incorporate such modifications and/or corrections and submit the final drawings for approval. Any delays arising out of failure by the Contractor to rectify the drawings in good time shall not alter the contract completions date.

The drawings/documents submitted for approval to the Employer shall be in triplicate. One print of such drawings shall be returned to the Contractor by the Employer marked with one of the categories as listed below:-

Category Inference

| | |
|---|---|
| Cat I | Approved/Released for implementation. |
| Cat II | Approved/Released for implementation subject to incorporation of comments. Revised drawing required. |
| Cat III | To be resubmitted for approval after incorporating comments. |
| Cat IV | For information and record. |

The approval of the drawing/document conveyed vide above marked copy shall neither relieve the Contractor of its contractual obligations and its responsibilities towards weights, qualities, design details, assembly fits, performance particulars and conformity of supplies with the Indian Statutory Laws as may be applicable, nor shall it limit Employer's right under the contract.

Depending upon the category of approval the Contractor shall resubmit the drawings/documents for review by Employer after incorporating all corrections.

Further work by the Contractor shall be strictly in accordance with the Cat-I, Cat-II or Cat-IV approved drawings and no deviation shall be permitted without the written approval of the Employer.

All manufacturing and fabrication work in connection with the equipment/material prior to the approval of the drawings shall be at the Contractor's risk. The Contractor may make any changes in the design which are necessary to make the equipment/material conform to the provisions and intent of the Contract and such changes will again be subject to approval by the Employer. Approval of Contractor's drawing or work by the Employer shall not relieve the Contractor of any of his responsibilities and liabilities under the Contract.

## 8.7 Final Documentation

Final documentation shall consist of the documents approved in Cat I and Cat IV listed in table 8-1. The documents will be used by the Employer personnel for operating and maintaining the equipment after acceptance.

Until acceptance of the equipment by the Employer, the Contractor shall be responsible for supplying documentation revisions or changes necessitated by inaccuracies, installation requirements, omissions determined by usage, and design or production alterations to the equipment. All changes shall be issued in the form of replacements for the affected drawings, diagrams, charts, graphs, tables, lists, and pages in the various documentation such that all documentation describes the equipment "as delivered".

For all CAT-I & CAT-IV approved documents listed in table (except Type, FAT & SAT related), seven (7) sets of the final approved documentation shall be provided to the Employer in CD-ROM and two sets in hardcopy.

All final Contractor-supplied documentation shall be easily reproducible by the Employer.

**Table 8-1**
**Documentation Plan for Communication Equipment Package**

| S. No | Document | Applicable Equipments / Item | Brief Description | Category of Approval |
|---|---|---|---|---|
| **1.** | Documentation plan & schedule | | This document shall contain the list of all documents to be submitted for approval and their submission/approval schedule. | I |
| **2.** | Survey guidelines | | As per Technical Specifications | I |
| 3. | Data Requirement Sheets (DRS) and Guaranteed Technical Parameters & Drawings | For each and every item to be supplied including OPGW Cable, Optical fibre, OPGW hardware & fittings, Approach cable, Joint Box, FODP, Primary Mux, D/I, DACS, SDH equipment, NMS, DCPS, Battery, power and signal cables, earthing cables, patch cords etc | These document(s) shall describe all the technical parameters of the equipment being offered. | Cat-I(for DRS) & Cat-IV (for brochure) |
| 4. | Sag Tension charts | For OPGW cable | Shall accompany the DRS document | I |
| 5. | Mechanical drawings | As applicable | This document shall fully describe the equipment racks/ enclosures, MDF, peripherals and related hardware with particular reference to mechanical construction, materials and dimensions, appearance, mounting methods, earthing clearances required from walls/roof/other panels, cable entry details, dust and moisture ingress protection provisions etc. | I |
| 6. | Equipment Manuals & | For all items | Complete set of all equipment manuals (Construction, | IV |

**Table 8-1**
**Documentation Plan for Communication Equipment Package**

| S. No | Document | Applicable Equipments / Item | Brief Description | Category of Approval |
|---|---|---|---|---|
| | Standard Documents | | Installation, Maintenance, Reference etc) for that product. A set of product brochures, photographs etc. | |
| 7. | Previous type test reports | For all items for which type testing is envisaged. | Shall be complete in all respect including all test graphs, curves, calculations, photographs etc. | IV |
| 8. | Type test procedures | For all items for which type testing is required. | Shall be formatted as per the technical specifications | I |
| 9. | Manufacturing Quality Plan | For all items to be supplied | | I |
| 10. | Type test schedule | For all items for which type testing is required. | Shall indicate the start & finish data for each test & sequence of tests if applicable, test labs. | I |
| 11. | Type test report | For all items for which type testing is required. | | I |
| 12. | Link and site survey reports & engineering analysis | For each Fibre Optic link and site | Link wise survey reports as per specifications, link calculations etc. | I |
| 13. | Bill of Quantity | For each items and each line | | I |
| 14. | Numbering, Marking, labeling Document | As applicable. | Must include numbering, marking, labelling and naming conventions for channels, cabels, connectors, subracks, cubicles etc | I |
| 15. | Physical planning/site preparation manuals | As applicable. | Must contain data gathered during the site survey, including test results, if any. The document shall also contain floor plan, cable trenching/raceway drawings, station block diagrams, rack/cabinet elevation | I |

**Table 8-1**
**Documentation Plan for Communication Equipment Package**

| S. No | Document | Applicable Equipments / Item | Brief Description | Category of Approval |
|---|---|---|---|---|
| | | | drawings, air-conditioning and power supply requirements, and power supply distribution and earthing system details. | |
| 16. | Channel Routing | Whole Network | E1 level Plan, subscriber voice and data channels plan for whole network. | I |
| 17. | Synchronisation Plan | Whole Network | Locations of clocks, depiction of all interfaces, flow of sychronising signal. | I |
| 18. | Configuration Diagrams | Whole Network | Network configuration, Link wise and site wise equipment configuration, NMS configuration. | I |
| 19. | NMS Description Document | NMS | Functional description of Hardware, Description of all commonly used and major functions in detail, Reference, User, Maintenance Manuals, Interfaces and channel requirements and routing, | IV |
| 20. | Factory Acceptance tests: test plan, procedures and report format | For all items to be supplied | This document shall include the list of Site acceptance tests, the administrative & functional test plans, test procedures and formats for recording & reporting factory acceptance test results. | I |
| 21. | Factory acceptance test report | For all Factory acceptance tests | | Acceptance letter by Employer |
| 22. | Transportation & Handling Procedures | For all items | This document shall describe the procedures & precautions to be observed during overseas & inland transportation, | IV |

**Table 8-1**
**Documentation Plan for Communication Equipment Package**

| S. No | Document | Applicable Equipments / Item | Brief Description | Category of Approval |
|---|---|---|---|---|
| | | | equipment handling during transport, storage & pre-installation. It shall also include packing details and package labeling details. | |
| 23. | Equipment Installation manual | For equipment types: Mux, D/I, DACS, SDH equipment, DCPS & Battery etc | The expected content of this document are presented in table below. | IV |
| 24. | FO Cable Installation manual | OPGW | The expected content of this document are presented in table 10.2 below | I |
| 25. | Jointing Manual | For each type of FO cable/joint box to be supplied | This document shall describe the installation of joint box (splice enclosures) and other jointing gang activities | I |
| 26. | Site Drawings | Site wise complete documentation | This document must include, general details of equipments, cubicles, cables, connectors, MDFs, DDFs, network diagram, earthing connections, power supply connections and specific details i.e. site layout, floor plans, cubicle layout, sub rack layout, channel routing, signal connections, cable routing, MDF and DDF cross connections etc | I |
| 27. | Site Acceptance tests (SAT) test plan, procedures and report format | System document | This document shall include the list of Site acceptance tests, the administrative & functional test plans, test procedures and formats for recording & reporting site acceptance test results. This document shall be restricted to describing the acceptance tests listed in this | I |

**Table 8-1**
**Documentation Plan for Communication Equipment Package**

| S. No | Document | Applicable Equipments / Item | Brief Description | Category of Approval |
|---|---|---|---|---|
| | | | technical specification, and other similar tests which shall be conducted in Employer presence for Site acceptance. | |
| 28. | Field Quality Plan | One Document with multiple subdocuments if required | Field Quality Plan shall describe the quality control to be exercised during the field activities. This document can include the following information:<br>(a.) The list of performance & safety checks applied to installation equipment, tools & tackles, checks, check on physical health & training records of installation crew etc.<br>(b.) The list of Site Acceptance tests (including statement of acceptance criteria). The inclusion of list of site acceptance tests in FQP is analogous to the inclusion of list of FAT in the MQP. The formats for recording & reporting Site acceptance tests can also be reproduced | I |
| 29. | Approach Cable Installation Document - General | Approach cable | This document shall describe the general approaches to be adopted for installation of Approach cables, for example the document shall try to answer questions such as whether cable trenches or cable raceways shall be used? Or whether any conduits/ ducts | Cat- I |

**Table 8-1**
**Documentation Plan for Communication Equipment Package**

| S. No | Document | Applicable Equipments / Item | Brief Description | Category of Approval |
|---|---|---|---|---|
| | | | will be used, if so, of what type? etc.<br><br>This document shall describe all allowable alternative installation methodologies, such that the actual implementation at a particular site shall be one or a combination of the methods described. The approach followed at a particular site shall be described based on this document in site by site documentation to be submitted later. | |
| 30. | Approach Cable & FODP layout document- site wise | For each site | To describe the layout of approach cable at each site and the floor plan of the FODP. | Cat- I |
| 31. | Training Manuals | System document | An advance copy of all training material. | IV |
| 32. | Maintenance Philosophy & Procedures | System document | Shall cover breakdown maintenance procedures, preventive maintenance schedules and procedures | IV |
| 33. | SAT reports | Per Link and per location | | * |

Note*: To be reviewed & approved by site.

**Table 8-2(a)**
**Expected Contents & Structure of Equipment Installation Manual**

| | | |
|---|---|---|
| 1. | Installation procedure | Description of activities of installation gangs: Preparation & Setting up, Precautions for preventing damage etc shall be highlighted. |
| 2. | Safety Instructions | Instructions & procedures related to ensuring installation crew safety: personnel grounding & safety, installation equipment safety, Safety for power system & environment |
| 3. | Description of Installation Equipment | Sketches, drawings, photographs, safe working ratings of installation equipment, tools & tackles etc., handling instructions & precautions. |
| 4. | Cable routing | Illustrations of the various possible cable routing (Intra cabinet and inter cabinet, within the same room and located in different rooms/buildings etc.) methods. |
| 5. | References | References to other related documents covering the installation, jointing & testing, such as<br>. SAT administrative & functional test plans & test procedures<br>. Field Quality Plan & Field Quality Audit<br>. Storage & Handling Instructions<br>. Drawings, technical parameters, DRS etc<br>. Employer & Statutory safety rules, safety manuals, standards, codes of practices etc. |

| Table 8-2b: Expected Contents & Structure of FO Cable Installation Manual for Overhead FO cable | | |
|---|---|---|
| 1. | Installation procedure | Description of activities of installation gangs: Preparation & Setting up, Stringing, sagging, attaching hardware, attaching down lead clamps & cable routing on the tower, securing cable ends (for protection before work by jointing gang). Precautions for preventing cable damage shall be highlighted. |
| 2. | Safety Instructions | Instructions & procedures related to ensuring installation crew safety: personnel grounding & safety, installation equipment safety, Safety for power system & environment (viz preventing accidental tripping, precaution for railway crossings etc) |
| 3. | Description of Installation Equipment | Sketches, drawings, photographs, safe working ratings of installation equipment, tools & tackles etc., handling instructions & precautions. |
| 4. | Cable routing | Illustrations of the positions of tower attachment clamps (down lead clamps), routing of FO cable on the tower, service loop(s), joint box position. |
| 5. | References | References to other related documents covering the installation, jointing & testing, such as<br>• SAT administrative & functional test plans & test procedures<br>• Jointing Procedures<br>• Field Quality Plan & Field Quality Audit<br>• Storage & Handling Instructions<br>• FO cable & hardware drawings, technical parameters, DRS etc<br>• Employer & Statutory safety rules, safety manuals, standards, codes of practices etc. |

**----------End of this Section----------**

# Section 09

# Project Management, Schedule and Implementation Plan

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# Section -09

# Project Management, Schedule and Implementation Plan

This section describes the project management, schedule, quality assurance, and implementation plan requirements for the project.

## 9.1 Project Management

The Contractor shall assign a project manager with the authority to make commitments and decisions that are binding on the Contractor. The project manager's responsibility shall include interface and coordination with the Project contractor(s). The Employer will designate a project manager to coordinate all the Employer project activities. All Project correspondence and communications between the Employer and the Contractor shall be coordinated through the project managers.

The project shall be staffed from the list of project management and engineering personnel presented in the proposal. Principal participants shall have previous experience in a similar position on at least two other projects of similar scope to this project. The assignment and reassignment of the Contractor's principal participants in the project shall be subject to the Employer's approval.

### 9.1.1 Reporting Period

The Project Manager shall provide updated project schedules and complete progress reports on monthly basis for the duration of the project. All references to the reporting period throughout this Specification shall refer to this monthly period.

### 9.1.2 Progress Meetings

The Project Manager shall schedule and attend Progress Meetings as deemed necessary but no less than once every two months.

### 9.1.3 Transmittals

Every document, letter, progress report, change order, and any other written or electronic media transmissions exchanged between Contractors and the Employer shall be assigned a unique transmittal number. Discussions and phone calls where project related information is exchanged shall be documented in a transmittal. The Contractor shall maintain a correspondence index and assign transmittal numbers consecutively for all Contractor documents. The Employer will maintain a similar correspondence numbering scheme identifying documents and correspondence that the Employer initiates.

### 9.1.4 Quality Assurance

#### 9.1.4.1 General

The Contractor shall adhere to a Quality Assurance (QA) program for the preparation of all Contract deliverables, including documentation, hardware, firmware and software. The program shall provide for early detection of actual or potential deficiencies, timely and effective corrective action, and a method of traceability of all such deficiencies.

The Bidder's proposal shall include the relevant ISO 9000 certificates from the main Bidder and from all subcontractors which have a major part (over 10%) of the delivery.

The relevant ISO 9000 standards to be provided are the following:

- ISO 9001: model for quality assurance in design, development, production, installation and servicing
- ISO 9002: model for quality assurance in production and installation
- ISO 9003: model for quality assurance in final inspection and testing

The Quality Assurance procedures, documentation standards, and software development procedures which were included with the Bidder's proposal will be incorporated into the Contract.

#### 9.1.4.2 Quality Assurance System and Requirements

The ISO 9001 Certificate and the assessment and visit reports shall be available to the Employer throughout the duration of the contract.

The Quality Assurance program shall be outlined by the Contractor and shall be finally accepted by the Employer after discussions before the award of contract. A Quality Assurance program of the Contractor shall generally cover but not limited to the following:

a. Organization structure for the management and implementation of the proposed quality assurance program.

b. Documentation control system.

c. Qualification data for Contractor's key personnel

d. The procedure for purchases of materials, parts/components and selection of sub-

Contractor's services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.

e. System for shop manufacturing including process controls and fabrication and assembly controls.

f. Control of non-conforming items and system for corrective action.

g. Control of calibration and testing of measuring and testing equipments.

h. Inspection and test procedure for manufacture.

i. System for indication and appraisal of inspection status.

j. System for quality audits

k. System for authorizing release of manufactured product to the Employer.

l. System for maintenance for records.

m. System for handling storage and delivery

n. A quality plan detailing out the specific quality control procedure adopted for controlling the quality characteristics of the product.

The Quality Assurance Plan shall be mutually discussed and approved by the Employer after incorporating necessary corrections by the Contractor as may be required.

This Quality Assurance plan shall then form part of the contractual documentation and shall not be changed without prior agreement with the Employer. The Contractor shall be required to submit all the Quality Assurance Documents as stipulated in the Quality Assurance Plan at the time of the Employer's inspection of equipment/material.

The Employer or his duly authorised representatives reserve the right to carry out Quality Audit and Quality Surveillance of the systems and procedures of the Contractor/his vendor's Quality Management and Control Activities.

### 9.1.4.3 Variance Reporting and Processing

An automated variance recording and tracking system shall be placed in service at least one month before the initially scheduled beginning of the FAT. This system shall be designed to record and track variances for documentation deficiencies, functional deficiencies, performance deficiencies, procedural deficiencies (as when deviations from contractually required QA

procedures are observed), and test deficiencies (as when the System cannot satisfactorily pass a step within a test procedure).

Variances may be initiated by both Contractor and the Employer personnel and shall be classified as follows:

a. Open (recorded but not necessarily agreed to)

b. Assigned (denoting acceptance by the Contractor)

c. Pending (denoting fixed, in the Contractor's opinion, and awaiting retest or verification)

d. Resolved (denoting the Employer acceptance or verification).

For the tracking of the variances and to support the automatic printout of subset lists, the following information fields shall be stored for each variance:

e. Variance number (automatically assigned)

f. Date initially recorded

g. Status (open/assigned/pending/resolved)

h. Date current status recorded

i. Names of the involved Employer personnel

j. Names of assigned Contractor personnel

k. Subsystem involved

l. Test name (where applicable)

m. Description (up to five lines in a full printout and part of the first line in a one-line-per-variance printout)

n. Urgency description (1, 2, or 3).

The variance recording and tracking system shall allow full printouts of all of the above information, condensed printouts of abbreviations of the above information (one-line-per-variance) and shall produce subsets of the variances based on searches of the fields singly or in combinations. For example, it shall be possible to produce a printout of all the variances (and

only those variances) that were at level 1 of 2 urgency, concerning a specific named subsystem, had open or assigned status, and were initiated within a named period.

Depending on its impact, each variance shall be assigned to one of three urgency levels by the Contractor with the Employer having level assignment approval rights.

level 1 Testing will stop for immediate evaluation and correction by the Contractor

level 2 Testing will continue and the variance will be corrected at the end of the current session or day

level 3 Testing will continue and the variance will be corrected and tested at a mutually agreed upon time (e.g., at the end of the test or later in the test period prior to shipment).

A variance status summary shall be included in the monthly project progress reports, and up-to-date variance reports shall be made available to the Employer on demand.

The variance recording and tracking system shall be subject to approval by the Employer.

#### 9.1.4.4 Additional Quality Assurance Requirements

The Employer shall have access to the Contractor's premises at any mutually agreed time and be provided access to inspect and assess the quality system should any specific need arise. The Employer shall also be able to conduct on site reviews as mutually agreed.

The Employer shall have access to any relevant documentation for verification that quality procedures are in accordance with the contract-specific quality plan.

### 9.1.5 Software Configuration Management

All software development performed by the Contractor shall be under a formal, documented software configuration management procedure. The procedure shall encompass the following aspects:

(a) Inventory control
(b) Version control
(c) Change control
(d) Build management.

The software configuration management scheme shall be managed by a designated software administrator(s). In case, the software is already a developed product, software configuration management shall begin at the time software is initially installed on the system. In case of new or

continuing development, software configuration management shall be immediately initiated during the earliest phases of development. The administrator(s) shall work closely with the Contractor software staff and shall be responsible for enforcing the software management procedures.

### 9.1.6 Document Review and Approval Rights

To ensure that the proposed systems conform to the specific provisions and general intent of the Specification, the Contractor shall submit documentation describing the systems to the Employer for review and approval.

The Employer will respond with written comments to the Contractor within thirty (30) calendar days after receipt of the documents. Documents requiring correction must be resubmitted by the Contractor to the Employer within 30 calendar days. The Employer will respond to resubmitted documents within fifteen (15) calendar days after receipt of the document. No implementation schedule relief is to be implied for documents requiring correction and resubmission to the Employer.

The Employer shall have the right to require the Contractor to make any necessary documentation changes at no additional cost to the Employer to achieve conformance with the Specification.

Any purchasing, manufacturing, or programming implementation initiated prior to written the Employer approval of the relevant documents or drawings shall be performed at the Contractor risk. Review and approval by the Employer shall not relieve the Contractor of its overall responsibilities to satisfy system functions and performance requirements in accordance with the Specification.

To help the Employer manage the review and approval of documents during any given period, the Contractor shall stagger the release of documents over the time allocated in the project schedule. The number and size of documents shall be factored into the document release schedule. At any time, no more than five documents shall be submitted to the Employer for review and approval.

## 9.2 Project Schedule

The project schedule shall consist of an implementation schedule, a documentation schedule, and a training schedule.

### 9.2.1 Implementation Schedule

The Contractor shall produce and maintain the implementation schedule. A copy of the implementation schedule files on a CD-ROM shall also be provided to the Employer. The overall

project plan shall consist of a Milestone Plan and a detailed Schedule Plan.

The Contractor shall provide a critical path analysis report and a manpower resource analysis report. Other standard reports will be defined during the Work statement.

Within two weeks of contract signing, the Contractor shall submit detailed project schedule, as described below. The project schedule shall include all tasks to track overall direction and integration of the project from inception through completion.

The Schedule Plan shall be developed utilizing the concept of Work Breakdown Structures. No task shall be greater than 3 weeks in duration.

The implementation schedule shall include the project milestones defined in Volume I, the Contractor activities and the Employer activities defined in this Section. The project schedule shall be an accurate representation of the progress and planned activities of the project.

The actual progress made to date and the scheduled delivery date for the completed systems shall be closely monitored by both the Contractor and the Employer project managers. The following information shall be reported to the Employer in a clear and concise manner using the tabular and graphic capabilities of the project management software:

(a) An overview and general assessment of all the Employer and Contractor activities and any progress or delays in these activities since the last reporting period

(b) Identification of tasks in the critical path together with an analysis indicating any required remedial action

(c) The amount of contingency time (float) remaining in the schedule

(d) Information on each task, including:

(1) Estimated start and finish dates
(2) Any change in the estimated dates since the last reporting period
(3) Estimated total number of calendar-days to complete the task
(4) Percent of task completed
(5) An indication of whether the start date was manually entered or computed.

(e) Total project resources

(f) The tasks to begin in the next two reporting periods
(g) The tasks to be completed in the next two reporting periods

(h) The tasks completed in the last two reporting periods

The content and format of the project schedule shall be subject to the Employer approval. The Contractor shall update and submit the project schedule to the Employer at least one week prior to each progress meeting.

#### 9.2.1.1 Contractor Activities

The implementation schedule shall be compiled by the Contractor summarizing all activities, and shall include but not be limited to the following:

(a) Survey, Design & Engineering
(b) Hardware purchases, development, and integration
(c) Hardware production schedules
(d) Documentation preparation and release
(e) Documentation revision and release following the Employer review
(f) Software design, coding, unit testing, and integration
(g) System integration
(h) Type Tests and Factory testing
(i) Shipment
(j) Receipt, forwarding and staging
(k) Installation
(l) Site Acceptance testing

Each scheduled task shall have an estimated duration for completion and predefined relationships with other tasks. Relationships shall be used to enforce the logical progression of work in as much as certain tasks cannot start until others have been completed.

#### 9.2.1.2 The Employer Activities

The implementation schedule shall contain all the Employer activities required in order for the Contractor to complete their systems and integration tasks, including the following:

(a) Document reviews and approvals
(b) Licensing and Regulatory Clearances, if any
(b) Participation in all levels of testing and training
(c) Any site preparations, if required.
(d) Assistance NMS database, display and report definition

### 9.2.2 Documentation Schedule

The documentation schedule shall include an entry for each document and drawing to be delivered throughout the project. Each documentation schedule entry shall include the document or drawing title, number, revision level, actual or future submittal date for the Employer review

or approval, date of completion of review or approval by the Employer, and outcome of review or approval by the Employer. When the Employer requires correction to any document, the documentation schedule shall be updated with a new entry for the next revision of the document. The content and format of the documentation schedule shall be subject to the Employer approval.

The documentation schedule shall allow for at least two submissions of each document requiring review or approval. The time schedule for document review or approval by the Employer shall be as specified in this section.

### 9.2.3 Training Schedule

The training schedule shall identify the dates of all of the training courses. The Contractor shall work with the Employer to determine the training schedule. The training schedule shall be subject to the Employer approval.

The appendices provide training requirement for this package. The training schedule shall accommodate the Constituent's availability of personnel in so much as it is possible.

## 9.3 Progress Reporting

With the intent to assure quality management and project progress as per the implementation schedule, progress reports submitted for each reporting period and Progress Review Meetings shall focus on the following:

### 9.3.1 Monthly Progress Reports

A Monthly Progress Report shall be prepared by the Project Manager that includes inputs from all its subsystem. The report shall be made available to the Employer as hard copy and soft copy, by the10th working day of each month and shall include but not be limited to:

(a) Updated project schedule highlighting any deviations from the previous issue of the project schedule

(b) Explanation and anticipated effect of each schedule deviation and its implication to the Employer.

(c) Schedule recovery plan for any deviation incurring a delay in delivery date. (All delays shall be factored into the project schedule as soon as they are known to the Contractor.)

(d) A summary of activities performed by the Contractor and the Employer during the previous reporting period

(e) An updated list of all correspondence transmitted and received by the Contractor

(f) Updated documentation schedule

(g) Updated training schedule

(h) List of all Contractor personnel and the Employer personnel resident at the Contractor facility, identifying all activities performed by each person and the activities scheduled for the next two reporting periods

(i) Updated list of Contractor and the Employer action items with status, description of required information, and required resolution dates

(j) Summary of pending and upcoming Contractor and the Employer activities during the next two reporting periods along with required completion dates

(k) Status of unresolved contract questions and change requests

(l) Summary of variances

(m) Log of invoice status

(n) Description of current and anticipated project problems and steps to be taken to resolve each problem.

### 9.3.2 Quarterly Progress Review Meetings

Progress Review Meetings shall be scheduled by the project managers and attended by the Contractor and the Employer to review progress of the project. Progress meetings shall be used to review the progress reports for the previous reporting periods, written correspondence exchanged since the last meeting, and open action items.

The Contractor shall also attend technical meetings as required to discuss technical aspects of the project and to review the Employer comments on approval documents. When appropriate, these splinter meetings shall be conducted as extensions to the progress meetings.

At least one-half of all meetings shall be held at the Employer's offices. Record the minutes of each meeting shall be prepared and provided as hard copies to all attendees on the same day whenever possible, but not later than within two working days after the meeting. Table 9-1 provides a suggested agenda for Progress Review Meetings.

**Table 9-1:**
**Suggested Progress Review Meeting Agenda**

| Item: | Title: | Description: |
|---|---|---|
| **1.** | **Meeting Minutes:** | Review minutes from previous meeting, with comments |
| **2.** | **Open Action Items:** | Review all outstanding action items |
| **3.** | **Progress Review:** | Review with participating Project Managers and Contractor, most recent project schedule. Update schedule and develop Action Items. |
| **4.** | **Technical Discussion:** | Discuss Technical Issues. |
| **5.** | **Action Items:** | Assign responsibilities for new action items. |
| **6.** | **Administrative Matters:** | Discuss administrative matters |
| **7.** | **Action Items:** | Assign responsibilities for action items. |
| **8.** | **Next Meeting:** | Schedule time and place for next meeting and agree on agenda |
| **9.** | **Adjourn:** | Adjourn meeting. |

## 9.4 Implementation Plan

The implementation of integrated wideband telecommunication system network with procurement under multiple Contracts and involvement of multiple agencies, requires careful planning and co-ordination. Consequently, this section describes the Employer's phased implementation strategy for the Communication Equipment Package of the project that is consistent with implementation plans of other package(s). The Bidders shall propose preliminary implementation plans that will follow the above approach. The Employer and the Contractor shall finalise the detailed implementation plan following the award of the contract.

### 9.4.1 Implementation Steps

The basic implementation steps pertaining to telecommunication system of the project are:

(a) Design & parameterize the integrated wideband network, including implementation strategies.

(b) Conduct site & route surveys, identify equipment locations and required site preparations.

(c) Subsystems design, manufacture, factory & type test (if applicable).

(d) Shipping, installation and field testing for above.

(e) Design, manufacture, factory and type test (if applicable) of termination equipment and NMS subsystems and other related equipment.

(f) Shipping, installation and field testing of above.

(g) Integration of FOTS, associated equipment, inside plant, PABX & PLC and integration with existing network.

(h) Field testing of the integrated telecommunication network including the NMS subsystem.

(i) Acceptance test and cutover support of the Project requirements of the integrated telecommunications network

Though not detailed, the above steps are intended to encompass all relevant work required to provide the Employer a fully working integrated telecommunication network supporting all Project commitments.

### 9.4.2 Implementation phases

The above implementation steps shall be organised and managed in various overlapping phases

## 9.5 Implementation Schedule

The implementation schedule for the Communication System Package shall be fifteen (15) months from the date of award. The fibre optic links which are essentially required for replacement of microwave shall be implemented on priority basis. These links shall be identified

during L-2 Schedule finalisation.

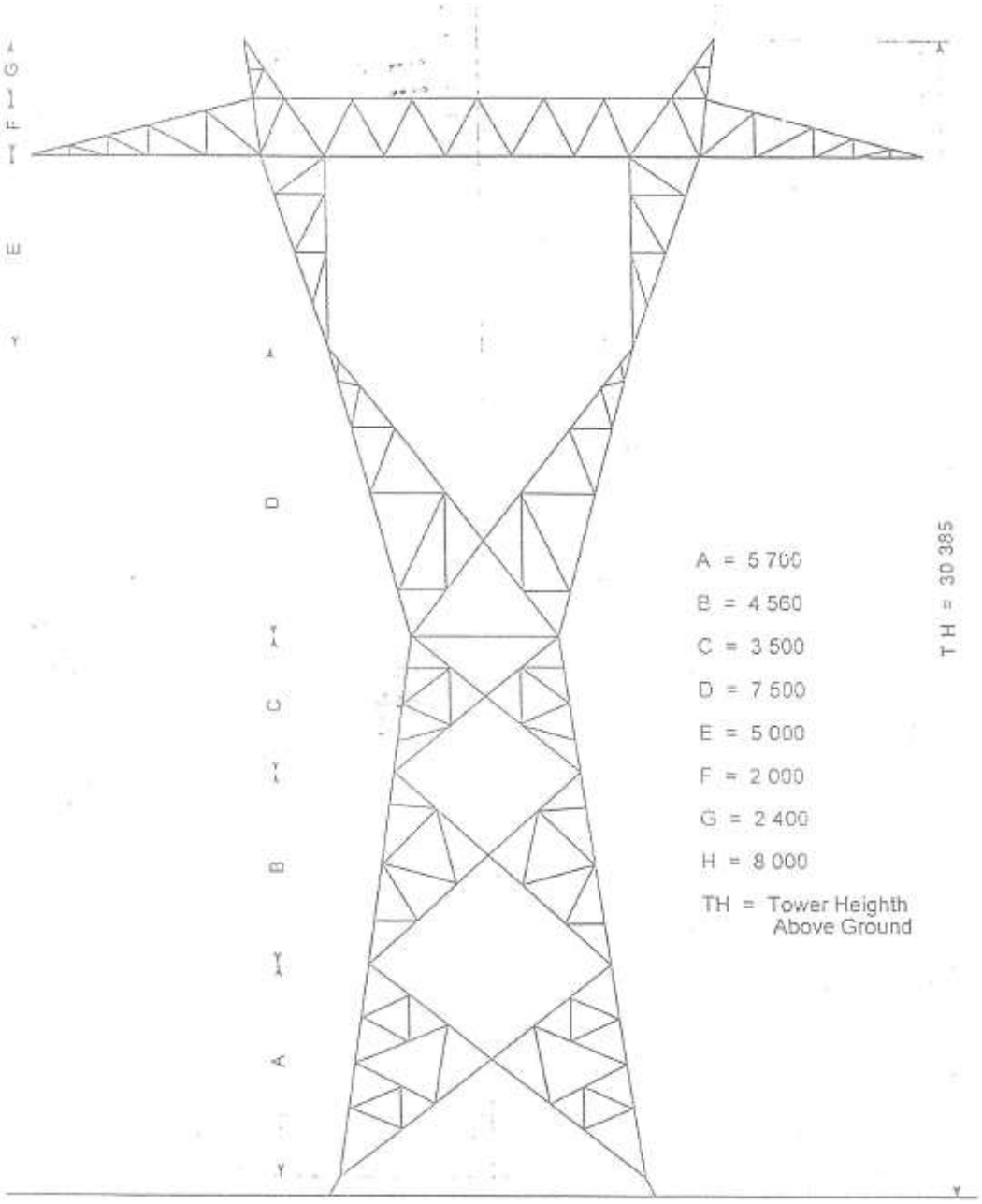
Appendix to this Technical Specifications provides a implementation schedule guidelines consistent with the phased implementation plan described herein and the Implementation Schedule for the Communication System Package.

**----------End of this Section----------**

# APPENDIX - A

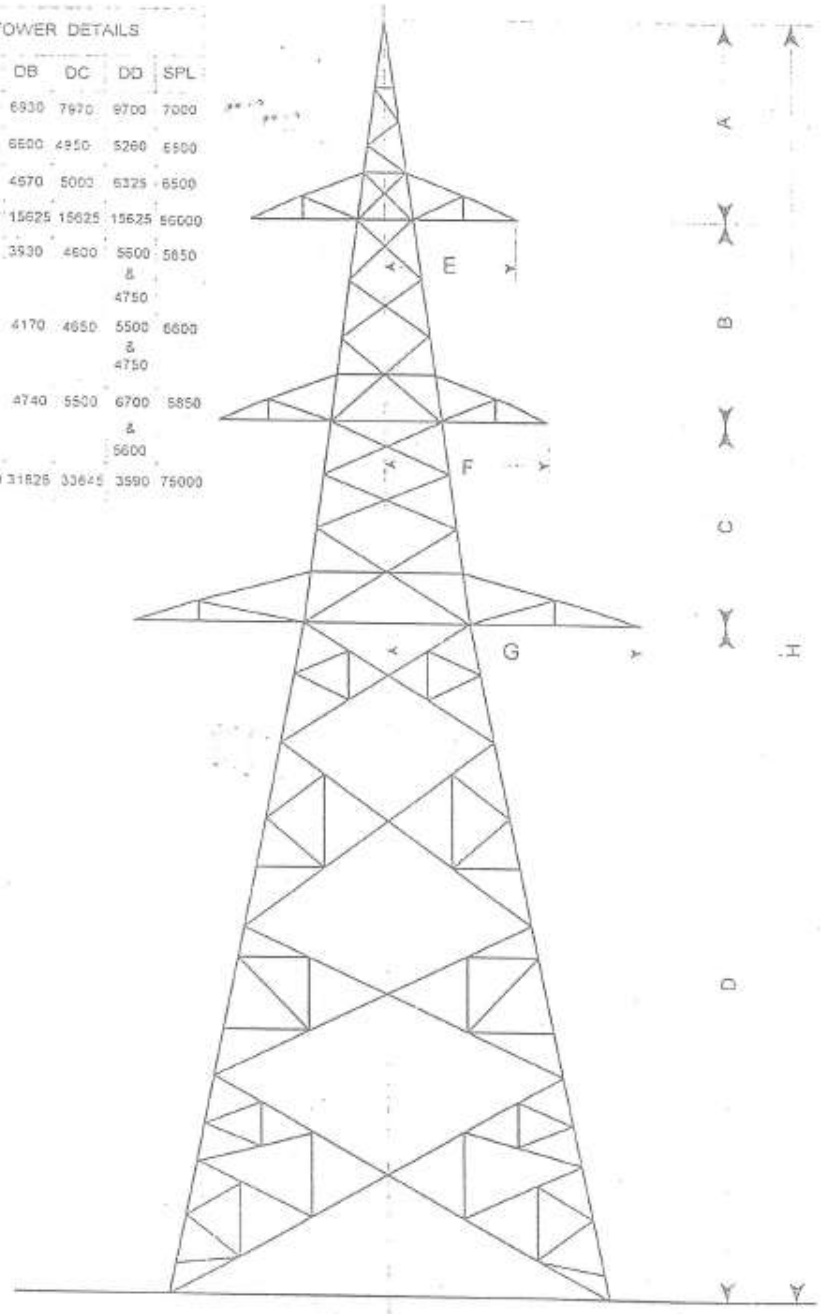
## General Network /Link Details and Implementation Schedule

# Typical tower drawings



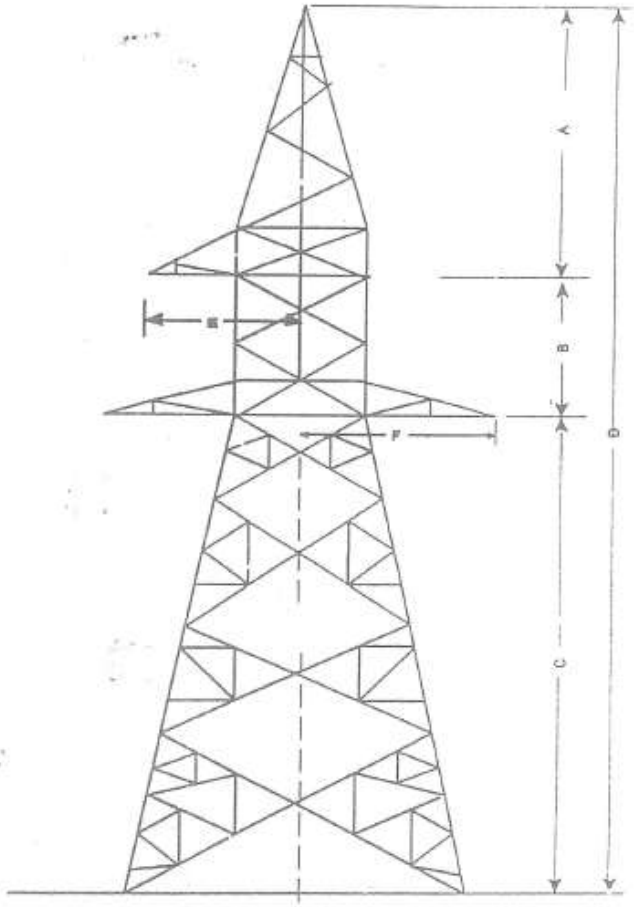

Typical 400 KV EHV Tower

| SL. NO. | DIMEN. (MTS) REF. DRAW ENCLOSED | TOWER DETAILS DA | DB | DC | DD | SPL |
|---|---|---|---|---|---|---|
| 1 | A | 3430 | 6930 | 7970 | 9700 | 7000 |
| 2 | B | 5205 | 6600 | 4950 | 5260 | 6500 |
| 3 | C | 5275 | 4570 | 5000 | 6325 | 6500 |
| 4 | D | 38580 | 15625 | 15625 | 15625 | 56000 |
| 5 | E | 4050 | 3930 | 4600 | 5500 & 4750 | 5850 |
| 6 | F | 4225 | 4170 | 4650 | 5500 & 4750 | 6600 |
| 7 | G | 4875 | 4740 | 5500 | 6700 & 5600 | 5850 |
| 8 | H | 29040 | 31826 | 33645 | 3590 | 75000 |




Typical 220 KV EHV Tower

| SL. NO. | DANEL DETAIL | TOWER DETAILS | | |
|---|---|---|---|---|
| | | AA | BB | |
| 1 | A | 3380 | 5830 | |
| 2 | B | 4050 | 4050 | |
| 3 | C | 27750 | 1350C | |
| 4 | D | 34990 | 33730 | |
| 5 | E | 3380 | 3830 | |
| 6 | F | 2891 | 3561 | |




Typical 132 kV Single Circuit Suspension/Tension Tower

**Table A-1**
**Typical transmission line details**

| Line Voltage | S/C or D/C | Nominal Span (E/W & Conductors in mtrs.) | Wind Zone as per IS 802 | Design Tension at Every Day Temp (32° C) and full wind condition – Earthwire) in kg for Wind Zone | Wind Pressure (kg/Sq-m) considering gust factor | Max Sag – Ground Wire at 53°C (in mtrs) | UTS – Earthwire (in Kg) | Weight – Earth wire (in Kg/km) | Minimum Clearance in mtrs. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | A1 | B1 | C1 |
| 400KV | S/C | 400 | IV | 3180.20 | 188.76 | 10.165 | 6974 | 0.583 | 8.84 | 8.0 | 9.0 |
| | D/C | 400 | IV | 3345.86 | 198.83 | 10.199 | 6972 | 0.583 | 8.84 | 8.0 | 9.0 |
| 220 kV | D/C | 350 | IV | 2543.88 | 192.00 | 7.684 | 5708 | 0.428 | 7.015 | 4.9 | 8.5 |
| | S/C | 350 | V | 2758.53 | 217.44 | 7.86 | 5708 | 0.428 | 7.015 | 4.9 | 8.5 |
| 132 kV | S/C | 320 | III | 2508.93 | 167.72 | 5.13 | 5708 | 0.428 | 6.1 | 3.9 | 6.1 |
| | S/C | 300 | V | 2806.86 | 212.474 | 4.504 | 5708 | 0.428 | 6.1 | 3.9 | 6.1 |
| | S/C | 320 | VI | 3255.30 | 262.31 | 5.13 | 5708 | 0.428 | 6.1 | 3.9 | 6.1 |

A1 Minimum clearance between conductor and ground (in meters)
B1 Minimum clearance between two phase conductors (in meters) – vertical in case of D/C towers and horizontal in case of S/C towers.
C1 Minimum clearance between conductor and earth wire (in meters)

State wise Wind Zones (As per IS 875-Part-3):

1. Arunachal Pradesh: III(Major Portion), IV
2. Assam: IV, V, VI
3. Mizoram: VI

*400KV- IV Zone,*
*220KV- IV & V Zone*
*132KV – III, V & VI Zone*

## Fig A-1: Implementation Schedule for Communication System package

| Task | Task Description | 15 Months | | | | | | | | | | | | | | Warranty Period | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Implementation Shedule** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 |
| 1 | Site Survey | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | Design & Engineering | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | Type testing | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | Manufacturing | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | Delivery at site | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | Site Installation | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | Site Acceptance Testing | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 8 | Warranty period | | | | | | | | | | | | | | | | | | | | | | | | | | | |

# Table A-2
# Proposed Fibre Optic Links

| S. No. | Constituents | Proposed Fibre Optic Links | | Line details | Proposed FO cable (in kms) |
|---|---|---|---|---|---|
| | | From | To | kV | OPGW |
| 1. | Central Sector | Badarpur (PG) | Silchar (PG) | 132* | 37 |
| 2. | | Gohpur | Itanagar (PG) | 132 | 45 |
| 3. | | Mariani | Mariani (PG) | 132* | 10 |
| 4. | | Namsai (PG) | Tinsukia | 132* | 100 |
| 5. | | Itanagar (PG) | Itanagar (SLDC) | 132* | 32 |
| 6. | | Badarpur (PG) | Kolasib | 132 | 108 |
| 7. | | Kolasib | Aizawl(PG) | 132 | 66 |
| | | | **Sub-Total** | | **398** |
| 1. | AEGCL | BTPS | Agia | 220 | 67 |
| 2. | | Agia | Sarusujai | 220 | 131 |
| 3. | | Namrup | Tinsukia | 132 | 49 |
| 4. | | Balipara | Gohpur | 132 | 75 |
| 5. | | Badarpur (PG) | Badarpur (AEGCL) | 132* | 4 |
| 6. | | Jiribam | Pailapool | 132 | 15 |
| 7. | | Pailapool | Srikona | 132* | 45 |
| 8. | | Badarpur (AEGCL) | Srikona | 132* | 15 |
| | | | **Sub-Total** | | **401** |
| 1. | Other Region (NR) | Maradnagar(400) | Shamli(220) | 220 | 85 |
| 2. | | Shamli(220) | Saharanpur(220) | 220 | 71 |
| 3. | | Panki(400) | Fatehpur | 220 | 94 |
| 4. | | Verpal | Raisheena | 220 | 22 |
| 5. | | Mohali(132) | Mohali(220) | 220 | 9 |
| 6. | | Pong | Daswa | 220 | 40 |
| 7. | | Kongo | Dehar | 220 | 3 |
| 8. | | Gangwal | Bhakra | 220 | 22 |
| | | | **Sub-Total** | | **346** |
| | | | **Grand Total** | | **1145** |

* Proposed(Future) Lines

# Table A-3: Site wise break up of Communication Equipments

| S.No | Location | SDH Eqpt (upto 2 direction) | Optical cards for SDH Eq.(up to 2 Dir) | | | | | | SDH Eqpt (> 2 dir.) | Optical cards for SDH Eq.(for more then 2 Dir) | | | | | | D&I Mux | 2 wire (sub/sub) | 4 wire (E&M) | Asynchronous | DACS | Cabinets (SDH) | Cabinets (MUX/DACS) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | S1.1 | S4.1 | L4.1 | L4.2 | OLI (upto 150km) | OLI (151-175km) | | S1.1 | S4.1 | L4.1 | L4.2 | OLI (upto 150km) | OLI (151-175km) | | | | | | | |
| | **Central Sector** | | | | | | | | | | | | | | | | | | | | | |
| 1 | Bongaigaon# | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 2 | BTPS | 1 | 0 | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 0 | 1 | 1 |
| 3 | Aizawl(PG) | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 0 | 1 | 1 |
| 4 | Silchar(PG) | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 0 | 1 | 1 |
| 5 | Ghopur# | 1 | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 6 | Itanagar(SLDC)* | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 0 | 1 | 1 |
| 7 | Namsai | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 0 | 1 | 1 |
| 8 | Tinsukia | 1 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 0 | 1 | 1 |
| 9 | Kolasib | 1 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 0 | 1 | 1 |
| 10 | Mariani(PG) | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 0 | 1 | 1 |
| 11 | Itanagar(PG) | 1 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 0 | 1 | 1 |
| 12 | Mariani(AEGCL)#* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| 13 | Badarpur(PG) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 2 | 2 | 0 | 2 | 0 | 2 | 2 | 2 | 2 | 1 | 1 | 2 |
| | **Sub Total (CS)** | **11** | **0** | **6** | **10** | **10** | **6** | **0** | **2** | **2** | **4** | **2** | **2** | **2** | **2** | **20** | **20** | **20** | **20** | **2** | **13** | **12** |

# Table A-4 (contd.) Site wise break up of Communication Equipments

| S. No | Location | SDH Eqpt (upto 2 direction) | Optical cards for SDH Eq.(up to 2 Dir) | | | | | | SDH Eqpt (> 2 dir.) | Optical cards for SDH Eq.(for more then 2 Dir) | | | | | | D&I Mux | 2 wire (sub/ sub) | 4 wire (E&M) | Asynchronous | DACS | Cabinets (SDH) | Cabinets (MUX/DACS) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | S1.1 | S4.1 | L4.1 | L4.2 | OLI (upto 150 km) | OLI (151-175km) | | S1.1 | S4.1 | L4.1 | L4.2 | OLI (upto 150km) | OLI (151-175km) | | | | | | | |
| | **AEGCL** | | | | | | | | | | | | | | | | | | | | | |
| 1 | Agia | 1 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 0 | 1 | 1 |
| 2 | Sarusajai# | 1 | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 3 | Balipara | 1 | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 0 | 1 | 1 |
| 4 | Badarpur (AEGCL) | 1 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 0 | 1 | 1 |
| 5 | Srikona | 1 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 0 | 1 | 1 |
| 6 | Pailapool | 1 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 0 | 1 | 1 |
| 7 | Jiribam | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 0 | 1 | 1 |
| 8 | Misa | 1 | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 0 | 1 | 1 |
| 9 | Samaguri | 1 | 0 | 0 | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 0 | 1 | 1 |
| 10 | Lakwa# | 1 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 11 | Namrup# | 1 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| | **Sub Total** | **11** | **6** | **10** | **8** | **12** | **4** | **2** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **16** | **16** | **16** | **16** | **0** | **11** | **8** |
| | **Grand Total** | **22** | **6** | **16** | **18** | **22** | **10** | **2** | **2** | **2** | **4** | **2** | **2** | **2** | **2** | **36** | **36** | **36** | **36** | **2** | **24** | **20** |

Note*: SDH Equipment considered in Central Sector
Note#: Existing Microwave Locations

# FIG-A2

## Proposed OPGW Network For North Eastern Region

**Fibre Optic Details**

| | |
|---|---|
| Central Sector | = 398 |
| AEGCL Portion | = 401 |
| OPGW in other Project | = 346 |
| **Total Fibre Optic Length** | **= 1145** |

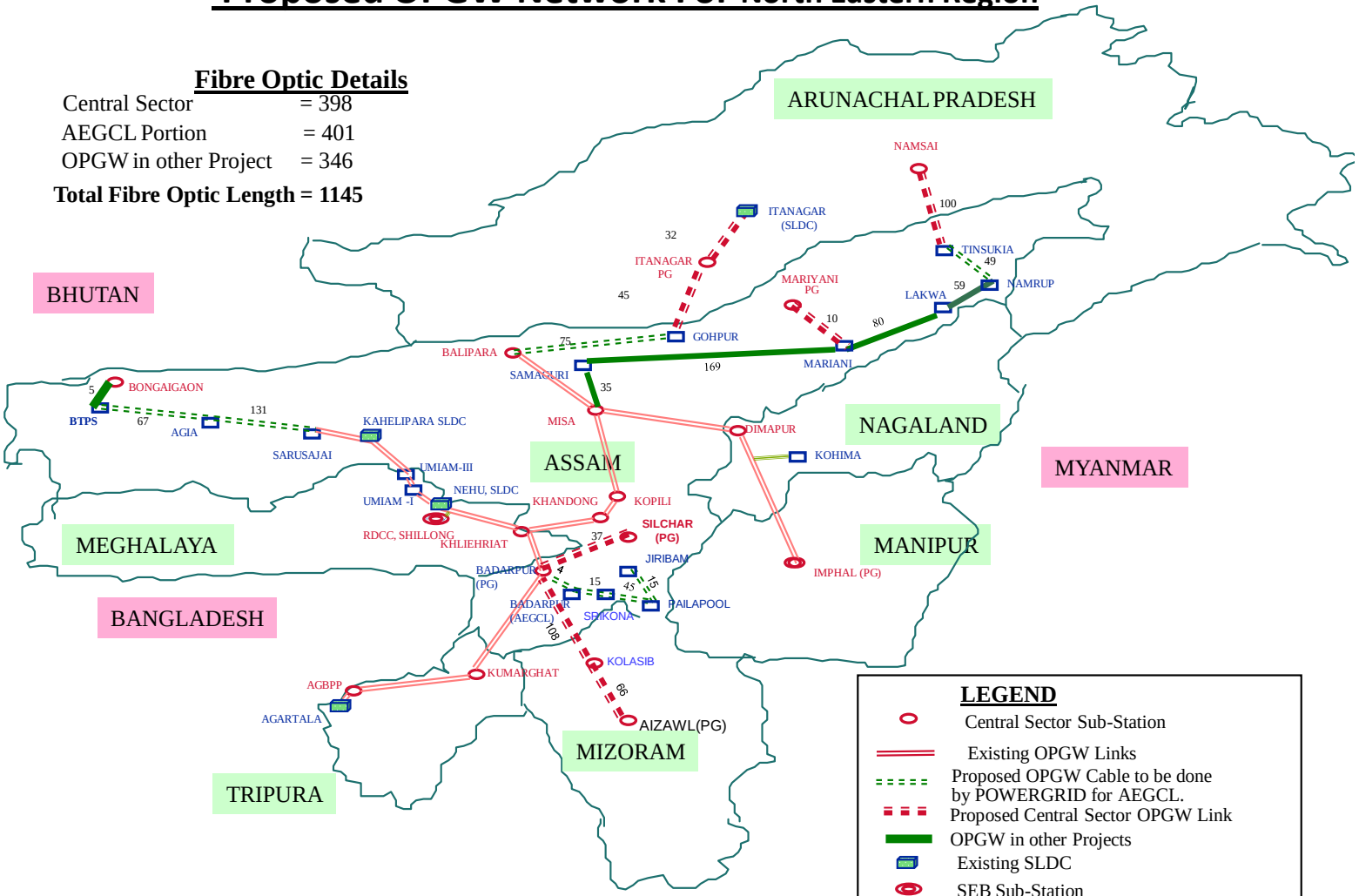
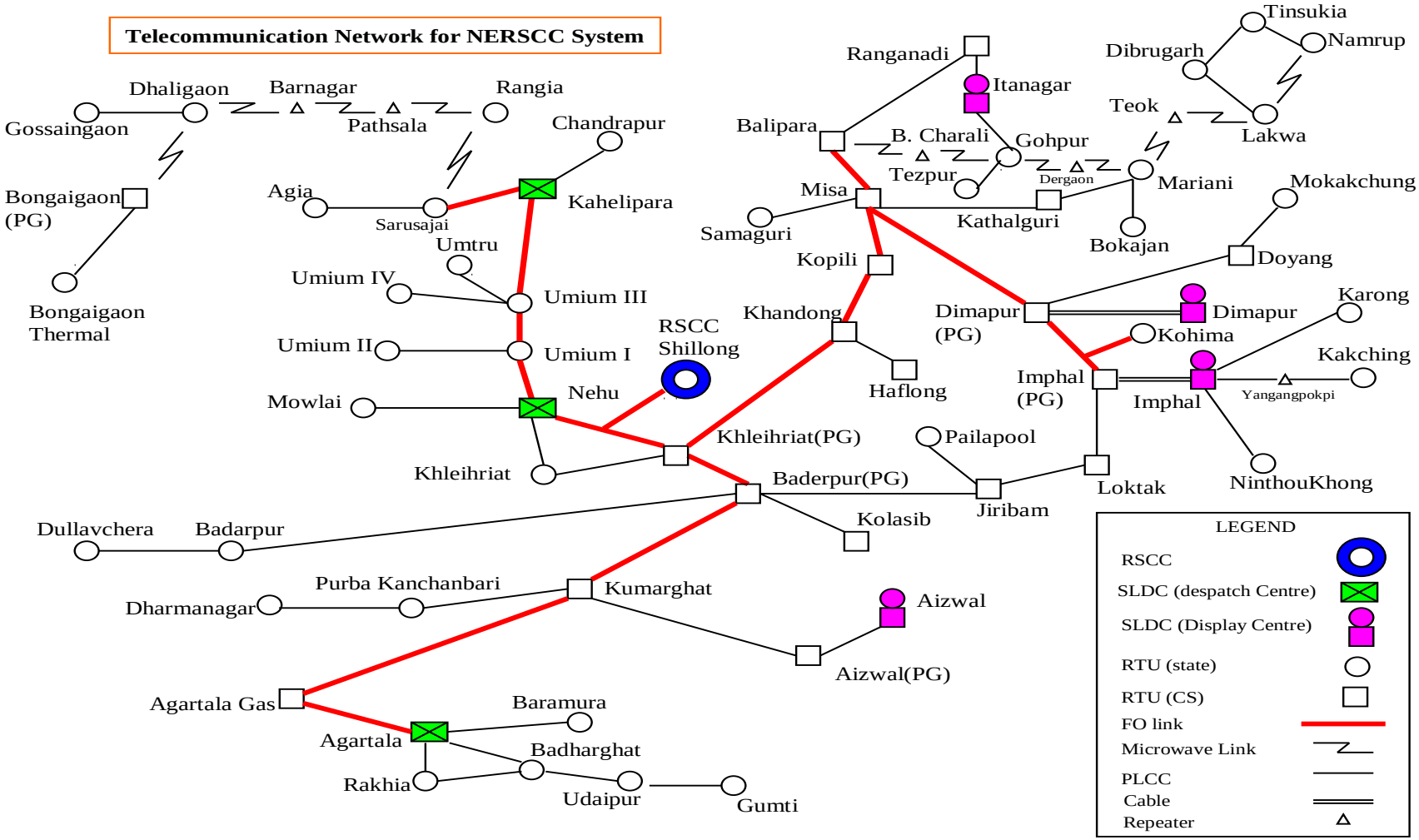


**Fig: A-3**

## EXISTING FO NETWORK OF NER



# APPENDIX B:

# BILL OF QUANTITIES

# Table -1
# BOQ for Overhead Optical Fibre Cabling

| Sr.No. | Item Description | Unit | CS | AEGCL | Other Region (NR) | TOTAL QTY |
|---|---|---|---|---|---|---|
| **A** | **OPGW cable & Accessories** | | | | | |
| 1 | 24 Fibre (DWSM) OPGW fibre optic cable | Km. | 398 | 401 | 346 | 1145 |
| 2 | Installation Hardware set for 24 Fibre OPGW Fibre Optic cabling including all cable fittings & accessories except joint box | Set/km * | 398 | 401 | 346 | 1145 |
| 3 | Joint box (24 Fibre) | No. | 133 | 134 | 115 | 382 |
| 4 | Supervision of stringing of OPGW during installation on new transmission line | Man days | 30 | 0 | 0 | 30 |
| 5a | Installation of OPGW (Live Line) | Km | 219 | 337 | 346 | 902 |
| 5b | Installation of OPGW(Off-line) | Km | 79 | 64 | 0 | 143 |
| **B** | **FODP** | | | | | |
| 1 | FODP 48F : Indoor Type, rack mounted with FCPC coupling and pig tails | No. | 9 | 7 | 6 | 22 |
| 2 | FODP 96 F : Indoor Type, rack mounted with FCPC coupling and pig tails | No. | 1 | 0 | 1 | 2 |
| **C** | **Fibre Optic approach cable** | | | | | |

| Sr.No. | Item Description | Unit | CS | AEGCL | Other Region (NR) | TOTAL QTY |
|---|---|---|---|---|---|---|
| 1 | 24 Fibre (DWSM) | Km. | 8 | 9 | 4 | 21 |
| 2 | Installation hardware set for above 24Fibre, Fibre Optic Approach Cable | Set/km* | 8 | 9 | 4 | 21 |
| D | Survey of Transmission line for OPGW | Km. | 398 | 401 | 0 | 799 |

**Note:** *One set of installation hardware shall contain all installation hardware fittings as may be required for 1 km of OPGW & Approach Fibre optic Cable.

## Table - 2
## BOQ for Telecom Equipment

| S.NO. | Item Description | Unit | CS | AEGCL | TOTAL QTY |
|---|---|---|---|---|---|
| **1.0** | **Transmission Equipment** | | | | |
| **A** | **SDH Equipment- STM 4 (ADM– up to two directions)** | | | | |
| **(I)** | Base Equipment (Common cards, Cross-connect/control cards, Optical base card, Power supply cards, power cabling, other hardware & accessories including sub-racks, patch cords, DDF etc. fully equipped excluding (II) and (III) below) | No. | 11 | 11 | 22 |
| **(II)** | **Optical Interfaces/SFP for:** | | | | |
| (a) | S1.1 | No.# | 0 | 6 | 6 |
| (b) | S4.1 | No.# | 6 | 10 | 16 |
| (c) | L4.1 | No.# | 10 | 8 | 18 |
| (d) | L4.2 | No.# | 10 | 12 | 22 |
| (e) | to support upto 150 kms for STM-4* | No.# | 6 | 4 | 10 |
| (f) | to support from 151 km to 175 km for STM-4* | No.# | 0 | 2 | 2 |
| **(III)** | **Tributary Cards** | | | | |
| (a) | E1 Interface card (Minimum 16 interfaces per card ) | No. | 22 | 22 | 44 |
| (b) | Ethernet interfaces 10/100 Mbps with Layer-2 switching (Minimum 4 interfaces per card.) | No. | 11 | 11 | 22 |
| **B** | **SDH Equipment – STM 4(ADM – more than two directions)** | | | | |
| **(I)** | Base Equipment (Common cards, Cross-connect/control cards, Optical base cards, Power supply cards, power cabling, other hardware & accessories including sub-racks, patch cords, DDF etc. fully equipped excluding (II) and (III) below) | Set** | 2 | 0 | 2 |
| **(II)** | **Optical Interfaces/SFP for:** | | | | |
| (a) | S1.1 | No.# | 2 | 0 | 2 |
| (b ) | S4.1 | No.# | 4 | 0 | 4 |

| S.NO. | Item Description | Unit | CS | AEGCL | TOTAL QTY |
|---|---|---|---|---|---|
| (c) | L4.1 | No.# | 2 | 0 | 2 |
| (d) | L4.2 | No.# | 2 | 0 | 2 |
| (e) | to support upto 150 kms for STM-4* | No.# | 2 | 0 | 2 |
| (f) | to support from 151 km to 175 km for STM-4* | No.# | 2 | 0 | 2 |
| **(III)** | **Tributary Cards** | | | | |
| (a) | E1 Interface card (Minimum 16 interfaces per card ) | Set** | 4 | 0 | 4 |
| (b) | Ethernet interfaces 10/100 Mbps with Layer-2 switching (Minimum 4 interfaces per card.) | Set** | 2 | 0 | 2 |
| **2.0** | **Termination Equipment** | | | | |
| **A1** | **Drop & Insert Multiplexer** Base Equipment (Common cards, Power supply cards, power cabling, other hardware & accessories including sub-racks, etc. fully equipped excluding subscriber line interface cards | No. | 20 | 16 | 36 |
| **A2** | **Subscriber Line Interface Cards** | | | | |
| a) | 2 wire (sub/sub) voice channel cards (min 8 channels per card) | No. | 20 | 16 | 36 |
| b) | 4 wire (E&M) voice channel cards (min 8 channels per card) | No. | 20 | 16 | 36 |
| c) | Asynchronous Sub Channels data cards (V.24/V.28) , minimum 4 channels per card | No. | 20 | 16 | 36 |
| **B.** | **Digital Access Cross Connect Switch (DACS)** 16 x 16 ports switching matrix, fully equipment for minimum 16 E-1 ports | No. | 2 | 0 | 2 |
| **3.0** | **Equipment Cabinets** | | | | |
| **a)** | **For Drop/Insert Multiplexer and DACS** | No. | 12 | 08 | 20 |
| **b)** | **For SDH Equipment** (including DDF patching facilities) & other accessories | No. | 13 | 11 | 24 |
| **4.0** | **NMS** | | | | |
| **(i)** | **Craft Terminal** | | | | |
| (a) | Hardware | Set | 1 | 1 | 2 |

| S.NO. | Item Description | Unit | CS | AEGCL | TOTAL QTY |
|---|---|---|---|---|---|
| (b) | Software | Set | 1 | 1 | 2 |
| **(ii)** | **Network Manager & Element Manager System** | | | | |
| (a) | Hardware | Set | 0 | 1 | 1 |
| (b) | Software | Set | 0 | 1 | 1 |
| (c) | Printer (Laser Jet) | No. | 0 | 1 | 1 |
| **5.0** | **Furniture for NMS hardware** | Set | 0 | 1 | 1 |
| **6.0** | **Main Distribution Frame (100 pairs)** | No. | 26 | 22 | 48 |
| **7.0** | **Synchronization Equipment** | | | | |
| | **GPS clock including all hardware & accessories** | Set | 1 | 0 | 1 |
| **C** | Reconfiguration and Integration with existing Telecom Equipment | Lot | 1 | 1 | 2 |

Note* : Suitable Optical Interface/SFP or any other solution such as optical amplifier, wavelength translator or higher aggregate bit rate SDH equipment may be offered to meet the link budget requirements without repeater.

Note**: set shall include quantity of SDH Base equipment with required hardware & accessories and supporting tributary cards to meet the criteria (One SDH equipment supporting more than two protected directions may be offered as per BoQ requirement)

Note# :Optical interface/SFP can be provided with Optical base card or Control card with the condition that control card shall not be equipped with more than one Optical interface/SFP and optical card with not more than two Optical interface/SFP. However main and protection channel shall be terminated on separate cards.

## Table-3: BOQ for Auxiliary Power Supply Equipments

| Sl. No. | Item Description | Unit | Quantity | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | CS | | AEGCL | | TOTAL | |
| | DCPS rating | | **15 A** | **25A** | **15 A** | **25A** | **15A** | **25A** |
| | Battery capacity | | **200 AH** | **300AH** | **200 AH** | **300AH** | | |
| **A.** | **Main Equipments** | | | | | | | |
| 1 | SMPS based 48V DC Power Supply (DCPS) system | ***Nos.*** | 11 | 02 | 11 | 0 | 22 | 02 |
| 2 | VRLA type Battery bank for above DCPS system | ***Nos.*** | 11 | 02 | 11 | 0 | 22 | 02 |

## Table- 4
## BOQ of Mandatory spares for Overhead Fibre Optic Cabling

| S.No. | Item Description | Unit | CS | AEGCL | Other Region(NR) | TOTAL QTY |
|---|---|---|---|---|---|---|
| **A** | **OPGW cable & Accessories** | | | | | |
| 1 | 24 Fibre (DWSM) OPGW fibre optic cable | Km. | 4 | 8 | 6 | 18 |
| 2 | Installation Hardware set for above OPGW Fibre Optic cabling including all cable fittings & accessories except joint box | Set/km * | 4 | 8 | 6 | 18 |
| 3 | Joint Box (24 fibre) | No. | 2 | 3 | 2 | 7 |
| **B** | **Fibre Optic approach cable** | | | | | |
| 1 | 24 Fibre (DWSM) | Km. | 2 | 2 | 1 | 5 |
| 2 | Installation hardware set for above 24 Fibre, Approach Fibre Optic Cable | Set/km * | 2 | 2 | 1 | 5 |

**Note**: *One set of installation hardware shall contain all installation hardware fittings as may be required for 1 km of OPG W & Approach Fibre Optic cabling.

## Table - 5
## BOQ of Mandatory spares for Telecom Equipment

| S.NO. | Item Description | Unit | CS | AEGCL | TOTAL QTY |
|---|---|---|---|---|---|
| **1.0** | **Transmission Equipment** | | | | |
| **A** | **SDH Equipment- STM 4 (ADM– up to two directions)** | | | | |
| **(I)** | Base Equipment (Common cards, Cross-connect/control cards, Optical base cards, Power supply cards, power cabling, other hardware & accessories including sub-racks, patch cords, DDF etc. fully equipped excluding (II) and (III) below) | Set[$$] | 1 | 1 | 2 |
| **(II)** | **Optical Interfaces/SFP for:** | | | | |
| (a) | S1.1 | No.[#] | 0 | 1 | 1 |
| (b) | S4.1 | No.[#] | 1 | 1 | 2 |
| (c) | L4.1 | No.[#] | 1 | 1 | 2 |
| (d) | L4.2 | No.[#] | 1 | 1 | 2 |
| (e) | to support upto 150 kms for STM-4* | No.[#] | 1 | 1 | 2 |
| (f) | to support from 151 km to 175 km for STM-4* | No.[#] | 0 | 1 | 1 |
| **(III)** | **Tributary Cards** | | | | |
| (a) | E1 Interface card (Minimum 16 interfaces per card ) | No. | 2 | 2 | 4 |
| (b) | Ethernet interfaces 10/100 Mbps with Layer-2 switching (Minimum 4 interfaces per card.) | No. | 1 | 1 | 2 |
| **B** | **SDH Equipment – STM 4(ADM – more than two directions)** | | | | |
| **(I)** | Base Equipment (Common cards, Cross-connect/control cards, Optical base cards, Power supply cards, power cabling, other hardware & accessories including sub-racks, patch cords, DDF etc. fully equipped excluding (II) and (III) below) | Set[@] | 1 | 0 | 1 |
| **(II)** | **Optical Interfaces/SFP for:** | | | | |
| (a) | S1.1 | No.[@] | 1 | 0 | 1 |
| (b) | S4.1 | No.[@] | 1 | 0 | 1 |
| (c) | L4.1 | No.[@] | 1 | 0 | 1 |
| (d) | L4.2 | No.[@] | 1 | 0 | 1 |

| S.NO. | Item Description | Unit | CS | AEGCL | TOTAL QTY |
|---|---|---|---|---|---|
| (e) | Optical Line Interface card (to support up to 150 kms)** | No.[@] | 1 | 0 | 1 |
| (f) | Optical Line Interface card(to support from 176Km to 200 Km)** | No.[@] | 1 | 0 | 1 |
| **(III)** | **Tributary Cards** | | | | |
| (a) | E1 Interface card (Minimum 16 interfaces per card ) | No.[@] | 1 | 0 | 1 |
| (b) | Ethernet interfaces 10/100 Mbps with Layer-2 switching (Minimum 4 interfaces per card.) | No.[@] | 1 | 0 | 1 |
| **2.0** | **Termination Equipment** | | | | |
| **A1** | **DROP/Insert Multiplexer** Common cards, Power supply cards, power cabling, other hardware & accessories (each) | Set[$$] | 2 | 2 | 4 |
| **A2** | **Subscriber Line Interface Cards**[#] | | | | |
| a) | 2 wire (sub/sub) voice channel cards (min 8 channels per card) | No. | 2 | 2 | 4 |
| c) | 4 wire (E&M) voice channel cards (min 8 channels per card) | No. | 2 | 2 | 4 |
| d) | Asynchronous Sub Channels data cards (V.24/V.28) , minimum 4 channels per card | No. | 2 | 2 | 4 |
| **C** | **Digital Access Cross Connect Switch (DACS)** Common cards, Power supply cards, power cabling, other hardware & accessories (each) | Set[$$] | 1 | 0 | 1 |
| **D** | **Pre Connectorized Optical Fiber Patch Cords (10 Mtrs) – Pack of six Patch cords** | Set | 2 | 2 | 4 |

Note*: Suitable Optical Interface/SFP or any other solution such as optical amplifier, wavelength translator or higher aggregate bit rate SDH equipment may be offered to meet the link budget requirements without repeater.

Note$$: One Set means one of each type of module/unit card etc

Note[#]: Include each type of optical base card which has been supplied under main quantity meeting the criteria of 10% spare

Note[@]: Exclude those items/sub-items (module cards etc.) which are covered under items1-B (SDH Equipment – ADM upto two directions)

## Table - 6
## BOQ of Mandatory spares for Auxiliary Power Supply Equipments

| Sl. No. | Item Description | Unit | Quantity | | |
|---|---|---|---|---|---|
| | | | CS | AEGCL | TOTAL |
| 1 | MCCB/MCB-2P/ Contactor/ Timer/ Relay of each type & rating (as applicable) | Set | 01 | 01 | 02 |
| 2 | Single Pole MCBs (for outgoing DC Feeders) | Nos. | 05 | 05 | 10 |
| 3 | Electronic Printed Circuit Board / Card of each type (all cards/module including SMPS Module, DC Power Supply Controller, various interface cards etc.) | Set | 01 | 01 | 02 |

**Table-7**
**BOQ for Test equipment**

| S.No. | Test equipment | Unit | Central Sector | AEGCL | TOTAL QTY |
|---|---|---|---|---|---|
| **A** | **Fiber Optic Cabling** | | | | |
| 1 | OTDR (Optical Time Domain Reflectometer) for 1310/1550 nm with laser source | **No.** | 1 | 1 | 2 |
| 2 | Optical Attenuators (variable 1310/1550nm) | **No.** | 0 | 1 | 1 |
| 3 | Optical Power meter (1310/1550nm) with Laser Source | **No.** | 0 | 1 | 1 |
| 4 | Optical Talk set | **No.** | 0 | 1 | 1 |
| 5 | Optical Fibre Fusion Splicer incl. Fibre cleaver | **No.** | 0 | 1 | 1 |
| 6 | Calibrated Fibre | **No.** | 0 | 1 | 1 |
| 7 | Connectorization kit | **No.** | 0 | 1 | 1 |
| 8 | Splice kit | **No.** | 0 | 1 | 1 |
| 9 | Optical test accessory kit including all necessary connectors, adaptors, cables, terminations and other items required for testing | **No.** | 0 | 1 | 1 |
| **B** | **Communication Equipment** | | | | |
| 1. | SDH Analyser[#] with Jitter and Wander Options | **No.** | 0 | 1 | 1 |
| 2. | Handheld 2Mbps BER Tester | **No.** | 0 | 1 | 1 |
| 3. | Digital Multimeter | **No.** | 0 | 1 | 1 |
| 4. | Ethernet Tester (with dual port, 10/100 ports Mbps Ethernet option, layer-1 & layer-2 functionality) | **No.** | 0 | 1 | 1 |

Note: [#]The testing capacity of SDH analyser shall be provided according to offered SDH equipment.

**Table-8**
**Proposed Training Requirements**

| S. No. | Item Description | Location | No. of trainees | | Duration in Working days |
|---|---|---|---|---|---|
| | | | Central Sector | AEGCL | |
| 1. | Training on Fibre Optic Cabling system including splicing of F.O. cable during installation | India | 3 | 6 | 4 |
| 2. | Training on SDH equipment, Mux Equipment, DACS & NMS | Manufacturer works/ Training centre | 3 | 6 | 4 |
| 3. | Training on DCPS & associated Battery | Manufacturer works/Training centre | 2 | 2 | 5 |

| Table -9<br>Maintenance for Communication System | | | |
|---|---|---|---|
| **S. No.** | **Items Description** | **Unit** | **Qty** |
| 1 | Maintenance for Communication System for one (1) year during Warranty period | Year | 1 |
| 2 | Maintenance for Communication System (excl. FO cabling) for Six (6) years after Warranty period | Year | 1 x 6 |

# APPENDIX-.C

# Data Requirement Sheets

# Appendix-C

## Data Requirement Sheets

The following sets of Data Requirement Sheets are required to be filled up by the bidders to aid in the evaluation process. The response shall be brief and to the point and shall be supported by the printed product description and other literature. The same DRS format duly filled and the relevant drawings shall also be submitted during the detailed engineering along with the relevant technical brochures.

DRS Form 1

**DATA REQUIREMENTS SHEETS for OVERHEAD FIBRE OPTIC CABLE**

OPTICAL GROUND WIRE (OPGW):

Manufacturer: _____
Part #: _____

Configuration: _____

| Seq | Parameter: | AS per Technical Specifications | As per Bidder Offering |
|---|---|---|---|
| **1.** | No. of Fibres<br>Dual Window Single-Mode: | 24 | |
| **2.** | Buffer Type: | Loose Tube | |
| **3.** | Buffer Tube material | Non-metallic | |
| **4.** | No. of Buffer Tubes: | Minimum Two (2) | |
| **5.** | No. of Fibres per buffer Tube: | Maximum Twelve(12) | |
| **6.** | Expected Cable Life: | 25 Year | |

DRS Form 2

**DATA REQUIREMENTS SHEETS for OPTICAL FIBRE**

DUAL-WINDOW SINGLE MODE (DW-SM)

| OPTICAL PARAMETERS | | | |
|---|---|---|---|
| **Seq** | **Parameter:** | **As per Technical Specifications** | **As per Bidder offering** |
| **1.** | Fibre manufacturer(s)/Type: | | |
| **2.** | Attenuation Coefficient@ 1310 nm<br>@ 1550 nm: | ≤ 0.35 dB/km<br>≤ 0.21 dB/km | |
| **3.** | Point discontinuity @ 1310nm:<br>@ 1550nm: | ≤ 0.1 dB<br>≤ 0.1 dB | |
| **4.** | Nominal Mode Field Diameter | 8.6 to 9.5 µm (± 0.6 µm ) | |
| **5.** | Chromatic Dispersion Coefficient<br>@ 1310 (1288-1339) nm:<br>@ 1310 (1271-1360) nm:<br>@ 1550 nm: | <br>3.5 ps/(nmxkm)<br>5.3 ps/(nmxkm)<br>18 ps/(nmxkm) | |
| **6.** | Zero dispersion wavelength: | 1300 to 1324 nm | |
| **7.** | Cut off wavelength: | ≤ 1260 nm | |
| **Physical and Mechanical Properties** | | | |
| **8.** | Bend Performance:<br>(37.5 mm radius, 100 turns) @1310 nm<br>(30 mm radius, 100 turn) @1550 nm<br>(16mm radius, 1 turn) @ 1550nm | ≤ 0.05 dB<br>≤ 0.05 dB<br>≤ 0.50 dB | |
| **11.** | Proof test level | ≥ 0.69 Gpa | |

DRS Form 03

## DATA REQUIREMENTS SHEETS for OPTICAL LINE TERMINATION EQUIPMENT (OLTE)

Manufacturer:_____
Model #: _____

**GENERAL OLTE FEATURES**

| Seq | Parameter: | As per Technical Specifications | As per Bidder Offering |
|---|---|---|---|
| **1.** | SDH hierarchy level:<br>Capacity Aggregate Bit-rate:<br>CEPT E-1<br>Ports: | STM-4<br>622 Mbps<br>252 x E1 | |
| **2.** | Is the equipment upgradable to STM-16 by changing optical line cards only? | Yes | |
| **3.** | No. of minimum protected(MSP) directions supported | Two | |
| **4.** | No. of ports in E1 tributary cards E1 ports | minimum 16 | |
| **5.** | No. of ports in Ethernet interface tributary cards | minimum 4 | |
| **6.** | Service Channel provision<br>a) Voice Channel<br>b) Data Channel | Yes<br>Minimum 1<br>Minimum 1 | |
| **7.** | Power Supply & Converters card of SDH equipment<br><br>Common Control* Card of SDH equipment | 1:1 APS or distributed power supply<br><br>1:1 APS | |

* = Common Control Cards which are essentially required for the operation of the equipment

DRS Form 04

**DATA REQUIREMENTS SHEETS for**

**Drop Insert MULTIPLEXERS**

Manufacturer:

_____

Model #:

_____

Configuration:

| Seq. | Parameter | As per Technical Specification | As per Bidder Offering |
|---|---|---|---|
| 1. | Output Aggregate Rate | 2.048 Mbps +/- 50 ppm | |
| 2. | Interface Code | HDB3 | |
| 3. | Impedance | 75 ohm unbalanced | |
| 4. | Maximum Insertion Loss | 6 dB | |
| 5. | Power Supply card of multiplexer | 1:1 APS or distributed power supply | |

The detailed DRS for all equipment/items are required to be submitted along with brochures during detailed engineering.

**----------End of the Appendix----------**